SINERGISE sentinelhub TOMTOM meteoblue Technical University of Munich SatCen

Global Earth Monitor

Deliverable 2.5

Integration of VHR sources

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PREPARATION SLIP			
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EXECUTIVE SUMMARY

New data gateways have been developed to allow the ingestion of very high-resolution data via Sentinel Hub. A preliminary list of supported sources is:

- Planet's PlanetScope data
- Airbus's Pléiades data
- Airbus's SPOT data
- Maxar's WorldView data

All supported sources show a detailed description of how to use, purchase, order, and access data. One or more images are added in each supported source, with an example of how the data looks. A tutorial on how to search and order data from third-party providers such as PlanetScope or Pléiades using Sentinel Hub API with Requests Builder is added.

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

SH	Sentinel Hub
BYOC	Bring your own cog
SPOT	Satellite for observation of Earth in French (“Satellite Pour l’Observation de la Terre”)
SH Dashboard	Sentinel Hub Dashboard
API	Application programming interface
SRTM	Shuttle Radar Topography Mission
DN	Digital numbers
NearIR1	Near Infrared
PAN	Panchromatic
GEO1	GeoEye-1
WV02	WorldView-2
WV03	WorldView-3
WV04	WorldView-4
TPDI	Third party data import
API	Application programming interface
OGC	Open Geospatial Consortium
AOI	Area of interest
EO	Earth observation
CRS	Coordinate reference system

1 Introduction

This document describes the fourth deliverable of WP2, which focuses on new data gateways developed to enable the ingestion of very high-resolution data via Sentinel Hub.

Section 2 provides a detailed description of the Third Party Data Import API (TPDI), which allows to import data from various data providers into Sentinel Hub. In the chapter you will find information on how to check API references with some examples. The workflow is closely related to our BYOC service, as purchased third-party data is imported into BYOC collections and accessible via Process or OGC API. All supported sources like Planet's PlanetScope data, Airbus's Pléiades data, Airbus's SPOT data, Maxar's WorldView data show a detailed description of how to use, purchase, order, and access data.

Section 3 describes step-by-step instructions on how to search and order third-party data such as PlanetScope or Pléiades using Sentinel Hub API with Requests Builder and Postman. The chapter also includes how to visualize purchased third-party data directly in the EO browser.

Section 4 demonstrates how to access data using sentinel-hub - eo-learn.

2 Third party data

The Third Party Data Import API (TPDI) enables to import data offered by different data providers into Sentinel Hub (SH). The API allows to search for available data and to order the import of selected data into Sentinel Hub. In Sentinel Hub, the data is stored in a BYOC collection and can be accessed using SH Process or SH OGC APIs.

Currently, we offer import for:

- Planet's PlanetScope data
- Airbus's Pléiades data
- Airbus's SPOT data
- Maxar's WorldView data

We are working on offering an import of more Third Party Data. To learn about the API for importing third party data, you can check out the API reference and examples. The list of supported CRS can be found here. Sentinel Hub converts the coordinates to http://www.opengis.net/def/crs/OGC/1.3/CRS84 before requesting the data from a provider.

2.1 Workflow

TPDI is very closely related to our BYOC service, since purchased third party data will be imported into BYOC collections and accessible through our Process or OGC API. We recommend not to mix different third party data types (e.g., PlanetScope, Pléiades, SPOT) and have one collection per kind. Error codes and error messages are forwarded from data provider's APIs, therefore more information about these can be found in their documentation.

Section 3 describes in more detail how to use a web tool to facilitate ordering and ingesting the high-resolution data, as well as using the purchased data through the Sentinel Hub APIs and with eo-learn. The following sections walk the reader through the needed steps to give the reader an overarching understanding of the procedure.

2.1.1 Searching data

The search API enables you to browse through the third party data archives. It is especially useful when you are not sure what data is available or which particular scenes you want to order. There are two different interfaces that can be used for searching. If you are not sure which one to use, we suggest you try out a Simple search first.

- Simple search - works in a unified manner across all data providers: it allows you to specify your area of interest, time period, maximal cloud coverage and a set of parameters specific for a data provider.
- Native search - is different for each data provider as it closely follows their search APIs. Depending on provider, it may return data that is not actually available for ordering or cannot be imported. To get only the orderable and importable results include the provider-specific filters as explained in the examples below. Note that the simple search always uses these filters in addition to the search parameters you provide. See examples of both approaches.

2.1.2 Order data import

Once you know which data you need, you can order an import into Sentinel Hub. Again, we offer two options for ordering:

- Order products - allows you to order specific items/products/scenes by specifying their ids. The ids will normally be extracted from the search results.
- Order using query - allows you to create an order by specifying your area of interest time period, cloud coverage (= query). This option allows you to create an order without search for the data first.

We suggest starting with Order products. See examples of both approaches.

To check the response of order data needs to be imported request to find an area, which will be deduced from balance in case of confirmed order. The easiest way of ordering first third party data product(s) is to leave the collectionId field in the order request empty, as the service automatically creates a BYOC collection for you according to the name specified in order request. For all subsequent orders of the same kind of data from the same provider, we suggest reusing the collectionId from the automatically created one to avoid an accumulation of collections in your dashboard.

In this way, newly ordered data will be imported into an existing collection, which brings about some benefits. It facilitates the simultaneous use of data from different orders, e.g. from a different point in time or area, and thus makes it easily accessible and comparable via one process request or in one theme layer in EO Browser (please check *step 6* in the step by step tutorial for instructions on how to display third party data in EO Browser).

2.1.3 Import data into existing BYOC collection

To import data into existing BYOC collection, needs to be provided a collectionId when ordering:

```
{
    "name": "...",
    "collectionId": "0X4a57dc-f0e8-4e82-bf96-f74c490422Yf",
    "input": {
        ...
    }
}
```

When ordering data import into an existing BYOC collection you must ensure that band names of new data match the band names of existing data in this collection. If not, the order will be created but the importing of data will fail (if and after the order is confirmed). The existing collection should use the S3 bucket sh.tpdi.byoc.eu-central-1. Otherwise, the request for creating an order will return an error.

2.1.4 Confirm order

To start the import of the data you will need to confirm your order. This is to protect you from accidentally creating (huge) orders. See the example of confirming an order.

After you confirm an import, we forward your order to the data provider and wait for them to prepare the data. Once the data is ready, we import the data into a SH BYOC collection. Data is imported asynchronously,

which means that it will not be returned in response, and you will need to wait a bit until the process finishes. You can always check the state of the order, see example. The state diagram below shows all possible statuses of an order and order part (= delivery), and actions which trigger transitions among them.

2.1.5 Data access

After the successful import of third party data, you can access it through our Process and OGC API, as well as display it in EO Browser. See the example for requesting a true colour image using a Process API request.

For instructions on how to display third party data in EO Browser, please check *step 6* in the step by step tutorial.

- Tutorials and Other Related Materials
- A webinar on Commercial data, where you will learn how to search, order and visualize commercial data, generate time-series and statistical information, import data into QGIS and get commercial data sponsored. January 20, 2021
- To get you started, we have prepared a step by step tutorial on ordering and visualizing commercial data using Requests Builder and Postman.

2.2 Planet

PlanetScope is one of the satellite constellations operated by Planet[1]. Sentinel Hub (SH) allows you to purchase, order and access PlanetScope data.

2.2.1 Planet scope data

The PlanetScope satellite constellation consists of more than 130 small satellites called Doves. Each Dove satellite is a CubeSat, which consists of three cubic units and thus measures only 10 cm x 10 cm x 30 cm. The satellites are launched in groups, which constantly improves mission characteristics such as revisit times, spatial and spectral resolutions. The constellation is constantly "on" and requires no acquisition scheduling.

PlanetScope data are an excellent source for vegetation monitoring. They complement the Sentinel-2 data by providing better spatial resolution and temporal coverage, which is especially important in cloudy areas because it increases the chance of capturing a cloud-free image.

Planet scope data has:

- Almost daily coverage worldwide
- 3.7-4.1 m pixel size (resampled to 3 m)
- Blue, Green, Red, Near Infrared (+Red Edge and more in near future)

[1] https://www.planet.com/products/planet-imagery/

Table 1: Basic facts Planet scope data

Property	Info
Spatial resolution	3 m (resampled)
Sensor	Four-band frame Imager: Blue, Red, Green and Near-Infrared band
Revisit time	1 day
Spatial coverage	global
Data availability	Global since 2016
Available measurements	Top of the atmosphere reflectance, Surface reflectance
Common usage/purpose	Land-cover maps, land-change detection maps, vegetation monitoring

2.2.2 Using, purchasing, ordering, and accessing PlanetScope data

The PlanetScope products are released under the license available here. If you already have Planet's api key, you can skip this section and proceed to ordering PlanetScope data. The process of purchasing PlanetScope data in Sentinel Hub is as follows:

- The pricing and conditions are available here[2]. To purchase a larger scope, an email must be sent to create a custom quote.
- Then you need to choose "Billing" section SH Dashboard and buy the Planet Scope plan.
- You will get an invitation from Planet to sign EULA, after which you will receive your Planet's API key.
- Once you have your Planet's API key you can proceed to Ordering PlanetScope Data.

For ordering of PlanetScope data you need your Planet API key. To order PlanetScope data, please use Third Party Import Data API.

PlanetScope data can be ordered through SH either as scaled *top of the atmosphere reflectance* or *surface reflectance*, according to the requested asset type. Furthermore, ordering usable data mask bands (UDM2) is optional. The value of the productBundle parameter specifies what will be ordered:

[2] https://www.sentinel-hub.com/pricing/

Table 2: productBundle parameter

productBundle value	Ordered Asset Type	Ordered Bands
analytic	top of the atmosphere reflectance	B1-B4 and UDM
analytic_udm2	top of the atmosphere reflectance	B1-B4 and UDM and UDM2
analytic_sr	surface reflectance	B1-B4 and UDM
analytic_sr_udm2	surface reflectance	B1-B4 and UDM and UDM2

Harmonization tool is applied by default. User can turn it off by setting "harmonizeTo" to "NONE" when placing an order. Harmonization is not supported for analytic_sr asset type. Other parameters are set by SH and cannot be changed by the user.

Table 3: Other parameters

Provider's parameter / tool	The values used by SH for ordering
item type	PSScene4Band
Top of Atmosphere Reflectance (toar) tool	is applied for asset type analytic with toar scale factor 10000 not applied for asset type analytic_sr
Clip tool	is applied

Accessing of the PlanetScope data is similar to accessing any other BYOC data. All processing and filtering options listed there can be used. However, the settings specific for accessing of PlanetScope data are listed below.

Table 4: Endpoints locations

Service	Notes
https://services.sentinel-hub.com/	Contains the data purchased by individual user

This chapter will explain the bands and data which can be set in the evalscript input object. Any string listed in the column Name can be an element of the input.bands array in your evalscript.

Table 5: Available Bands and Data

Name	Description	Resolution
B1	Blue, 455 - 515 nm	3m
B2	Green, 500 - 590 nm	3m
B3	Red, 590 - 670 nm	3m
B4	Near Infrared, 780 - 860 nm	3m
UDM	Unusable Data Mask	3m
UDM2_Clear*	Usable Data mask - Clear mask	3m
UDM2_Snow*	Usable Data mask - Snow mask	3m
UDM2_Shadow*	Usable Data mask - Shadow mask	3m
UDM2_LightHaze*	Usable Data mask - Light haze mask	3m
UDM2_HeavyHaze*	Usable Data mask - Heavy haze mask	3m
UDM2_Cloud*	Usable Data mask - Cloud mask	3m
UDM2_Confidence*	Usable Data mask - Confidence map	3m
dataMask	The mask of data/no data pixels (more).	N/A**

* The UDM2 bands are available only for orders where the productBundle field is set to analytic_udm2 or analytic_sr_udm2.

** dataMask has no source resolution as it is calculated for each output pixel.

The data values for each band in your custom script are presented in the default units as specified here. In case more than one unit is available for a given band, you may optionally set the value of input.units in your evalscript setup function to one of the options. Doing so will present data in that unit. The Source Format specifies how and with what precision the digital numbers from which the unit is derived are encoded. The Typical Range indicates what values are common for a given band and unit, however outliers can be expected. For PlanetScope bands, DN (digital numbers) are the default and only unit. Reflectance values can be obtained using the simple formula: reflectance = DN / 10000.

Table 6: Units

Band	Unit	Source Format	Typical Range
Optical bands B1 - B4	DN	UINT16	0 - 4000
UDM	bit mask	UINT8	0 - fully usable data other - potentially problematic/unusable data
UDM2_Clear	N/A	Boolean	0 - not clear 1 - clear
UDM2_Snow	N/A	Boolean	0 - not snow 1 - snow
UDM2_Shadow	N/A	Boolean	0 - not shadow 1 - shadow
UDM2_LightHaze	N/A	Boolean	0 - not light haze 1 - light haze
UDM2_HeavyHaze	N/A	Boolean	0 - not heavy haze 1 - heavy haze
UDM2_Cloud	N/A	Boolean	0 - not cloud 1 - cloud
UDM2_Confidence	%	UINT8	0 - 100
dataMask	N/A	Boolean	0 - no data 1 - data

All mosaicking types are supported. Here are PlanetScope examples[3].

2.3 SPOT

SPOT 6/7 is a satellite constellation providing very high-resolution optical imagery and is owned by Airbus. Sentinel Hub (SH) allows you to purchase, order and access SPOT data.

[3] https://docs.sentinel-hub.com/api/latest/data/planet-scope/examples/

2.3.1 SPOT data

SPOT 6/7 is composed of two twin satellites orbiting the Earth 180° apart. The satellites deliver 1.5 m optical imagery and offer a daily revisit capability to any point on the globe. SPOT 6/7 data with its high spatial resolution is suitable for a range of remote sensing applications such as vegetation monitoring, precise mapping, risk and disaster management.

Table 7: basic facts SPOT

Property	Info
Spatial resolution	1.5 m for panchromatic band and 6 m for all other bands
Sensor	Multispectral Imager, 5 bands: panchromatic, Blue, Red, Green and Near-Infrared band
Revisit time	Up to a daily revisit of any point on the globe.
A data acquisition must be tasked, data is not acquired systematically.	
Spatial coverage	global
Data availability	Since September 2012
Measurement	Top of the atmosphere (TOA) reflectance
Common usage/purpose	vegetation monitoring, risk and disaster management, urban and mapping applications, civil engineering

2.3.2 Using, purchasing, ordering, and accessing SPOT data

More information could be found here[4]. The SPOT products are released under the license available here.

The process of purchasing[5] of SPOT data in Sentinel Hub goes as follows:

- Here are pricing and conditions. To buy bigger area an e-mail needs to be sent and after that custom offer will be prepared.
- The "Billing" section in SH Dashboard needs to be checked and the Airbus SPOT plan could be bought.
- Once the payment is processed, a confirmation is sent to proceed with ordering the data.

To order SPOT[6] data, Third Party Import Data API needs to be used.

SH uses the following settings when ordering SPOT data:

[4] https://www.intelligence-airbusds.com/en/8577-spot-67-user-guide-download
[5] https://docs.sentinel-hub.com/api/latest/data/airbus/spot/#purchasing-spot-data
[6] https://docs.sentinel-hub.com/api/latest/data/airbus/spot/#ordering-spot-data

Table 8: Settings for ordering SPOT data

Provider's parameter / tool	The values used by SH for ordering
product type	bundle
radiometric processing	REFLECTANCE
crs	UTM zone corresponding to user defined bounds
processing level	SENSOR or ALBUM

Accessing[7] of the SPOT data is like accessing any other BYOC data. All processing and filtering options listed there can be used. However, the settings specific for accessing of SPOT data are listed below.

Table 9: Endpoints Locations - SPOT

Service	Notes
https://services.sentinel-hub.com/	Contains the data purchased by individual user

Table 10: Available Bands and Data

Name	Description	Resolution
B0	Blue, 454-519 nm	6m
B1	Green, 527-587 nm	6m
B2	Red, 624-694 nm	6m
B3	Near Infrared, 756-880 nm	6m
PAN	Panchromatic, 455-744 nm	1.5m
dataMask	The mask of data/no data pixels (more).	N/A**

The data values for each band in custom script are presented in the default units[8] as specified here. In case more than one unit is available for a given band, is possible optionally set the value of input.units in evalscript setup function to one of the options. Doing so will present data in that unit. The Source Format specifies how and with what precision the digital numbers from which the unit is derived are encoded. The Typical Range indicates what values are common for a given band and unit, however outliers can be

[7] https://docs.sentinel-hub.com/api/latest/data/airbus/spot/#accessing-spot-data
[8] https://docs.sentinel-hub.com/api/latest/data/airbus/spot/#units

expected. For SPOT bands, DN (digital numbers) are the default and only unit. Reflectance values can be obtained using the simple formula: reflectance = DN / 10000.

Table 11: Available bands

Band	Unit	Source Format	Typical Range	Note
Optical bands B0 - B3, PAN	DN	UINT16	0 - 4000	Highly reflective pixels can have values above 10000.
dataMask	N/A	Boolean	0 - no data	

All mosaicking types are supported. Here you can see SPOT examples.

2.4 Pléiades

Pléiades[9] is a satellite constellation providing very high-resolution optical imagery and is owned by Airbus. Sentinel Hub (SH) allows you to to purchase, order and access Pléiades data.

2.4.1 Pléiades data

Pléiades[10] is composed of two twin satellites orbiting the Earth 180° apart. The satellites deliver 0.5 m optical imagery and offer a daily revisit capability to any point on the globe. A data acquisition must be tasked, and various collection scenarios are available: Target, Strip Mapping, Tri-Stereo, Corridor and Persistent Surveillance. Pléiades' satellites share the orbit with SPOT satellites, which makes it possible to combine the data form both sources. The Pléiades data with its high spatial resolution is suitable for a range of remote sensing applications such as vegetation monitoring, precise mapping, risk, and disaster management.

Table 12: Basic facts - Pléiades

Property	Info
Spatial resolution	0.5 m for panchromatic band and 2 m for all other bands
Sensor	Multispectral Imager, 5 bands: panchromatic, Blue, Red, Green and Near-Infrared band
Revisit time	Up to a daily revisit of any point on the globe.
A data acquisition must be tasked, data is	

[9] https://www.intelligence-airbusds.com/en/8692-pleiades
[10] https://www.cscrs.itu.edu.tr/assets/downloads/PleiadesUserGuide.pdf

not acquired systematically.	
Spatial coverage	global
Data availability	Since December 2011
Measurement	Top of the atmosphere (TOA) reflectance
Common usage/purpose	vegetation monitoring, risk and disaster management, urban and mapping applications, civil engineering

2.4.2 Using, purchasing, ordering, and accessing Pléiades data

The Pléiades products are released under the license available here[11]. The process of purchasing of Pléiades data in Sentinel Hub goes as follows:

- Check the pricing and conditions. To buy bigger area send an e-mail to prepare a custom offer.
- Go to the "Billing" section in SH Dashboard and buy the Airbus Pléiades plan.
- Once the payment is processed, a confirmation will be sent to be able to proceed with ordering the data.

To order Pléiades data, please use our Third Party[12] Import Data API. SH uses the following settings when ordering Pléiades data:

Table 13: Settings when ordering Pléiades data

Provider's parameter / tool	The values used by SH for ordering
product type	bundle
radiometric processing	REFLECTANCE
crs	UTM zone corresponding to user defined bounds
processing level	SENSOR or ALBUM

Once order is successfully finished the ordered data will be available in one of BYOC collections and ready to be used. To access the data, you need the id of this collection. Accessing of the PlanetScope data is similar to accessing any other BYOC data. All processing and filtering options listed there can be used. However, the settings specific for accessing of Pléiades data are listed below.

[11] https://docs.sentinel-hub.com/api/latest/static/files/data/airbus/pleiades/resources/license/20200309-Standard_Licence_Living_Library.pdf
[12] https://docs.sentinel-hub.com/api/latest/api/data-import/

Table 14: Endpoint Locations

Service	Notes
https://services.sentinel-hub.com/	Contains the data purchased by individual user

- Filtering Options

CollectionId - Use the id of the BYOC collection into which your Pléiades data was delivered as a value of parameter input.data.dataFilter.collectionId in the process API requests. See BYOC data access for more information.

- Available Bands and Data

This chapter will explain the bands and data which can be set in the evalscript input object: Any string listed in the column Name can be an element of the input.bands array in your evalscript.

Table 15: Available bands and Data

Name	Description	Resolution
B0	Blue, 430-550 nm	2m
B1	Green, 490-610 nm	2m
B2	Red, 600-720 nm	2m
B3	Near Infrared, 750-950 nm	2m
PAN	Panchromatic, 480-830 nm	0.5m
dataMask	The mask of data/no data pixels (more).	N/A**
Name	Description	Resolution

The data values for each band in your custom script are presented in the default units as specified here. In case more than one unit is available for a given band, you may optionally set the value of input.units in your evalscript setup function to one of the options. Doing so will present data in that unit. The Source Format specifies how and with what precision the digital numbers from which the unit is derived are encoded. The Typical Range indicates what values are common for a given band and unit, however outliers can be expected. For Pléiades bands, DN (digital numbers) are the default and only unit. Reflectance values can be obtained using the simple formula: reflectance = DN / 10000.

Table 16: Units

Band	Unit	Source Format	Typical Range	Note
Optical bands	DN	UINT16	0 - 4000	Highly reflective pixels can have values above 10000.
dataMask	N/A	Boolean	0 - no data	

Here you can see examples[13] and all mosaicking[14] types are supported.

2.5 Worldview

WorldView provides high resolution optical imagery and is owned by Maxar. Sentinel Hub (SH) allows you to order WorldView data through European Space Imaging.

2.5.1 Worldview data

The WorldView constellations consists of four active satellites: WorldView-1 (data not available in SH), GeoEye-1 (GE01), WorldView-2 (WV02), and WorldView-3 (WV03). The WorldView-4 (WV04) satellite was operational from November 2016 to January 2019 and the data it acquired is available in SH. More information on the specific missions can be checked in this brochure.

Table 17: Basic Facts Worldview

Property	Info
Spatial resolution	Varies from 0.3m to approx. 2m. SH supports 0.5 m for panchromatic band and 2 m for multispectral bands.
Sensor	Multispectral Imagery, 5 bands are supported in SH: panchromatic, Blue, Red, Green and Near-Infrared band.
Revisit time	From approx. 1 day to 3 days depending on the satellite. Note that the data is in general not acquired systematically. Archive data is available sporadically over an area of interest. In case you need systematic monitoring of a specific area, contact us to order tasking (different pricing conditions apply).
Spatial coverage	Global
Data availability	Since 2009
Measurement	Top of the atmosphere (TOA) reflectance
Common usage/purpose	Land-cover maps, land-change detection maps, vegetation monitoring, defence, traffic, marine monitoring

[13] https://docs.sentinel-hub.com/api/latest/data/airbus/pleiades/examples/
[14] https://docs.sentinel-hub.com/api/latest/evalscript/v3/#mosaicking

2.5.2 Using, purchasing, ordering, and accessing Worldview data

The WorldView products are released under the license available here. The process of purchasing of WorldView data in Sentinel Hub goes as follows:

- The pricing and conditions to be checked.
- To buy a bigger area, an e-mail needs to be sent and a custom offer prepared.
- In the "Billing" section SH Dashboard the WorldView plan can be bought.
- Once the payment is processed, data to European Space Imaging for a compliance check (only first purchase) are provided. After a confirmation (usually the next working day), a confirmation will be sent to be able to proceed with ordering the data.

To order WorldView data Third Party Data Import API needs to be used. To access WorldView data needs to be set the TPDI provider parameter to MAXAR, like so: "provider": "MAXAR".

Table 18: Settings used by SH when ordering WorldView data.

Provider's parameter / tool	The values used by SH for ordering	Description
productBands	4BB	4 band bundle, which contains panchromatic, red, blue, green and near IR bands.
fullOverlap	true	All scenes intersecting requested AOI will be ordered.
fullStrip	false	Data will be clipped to the AOI provided in the payload.
productLevel	ORTHO	Map-ready 1:12,000 orthorectified products.
productBits	16 bit	Requested bit depth of data.
productProjection	WGS84_UTM	Data is delivered to SH in UTM projection.
productGsd	0.5 m	Data is resampled so that the spatial resolution of panchromatic band is 0.5m and 2m for multispectral bands.

We convert the DN we get from the provider to the top of the atmosphere reflectance and multiply them by a factor of 10000.

- The minimum area to be ordered for WorldView data is 5 km^2. Area of interest intersects with multiple WorldView scenes must be greater than 5 km^2.

- The specified absolute horizontal positional accuracy of WorldView ORTHO products is 10.2 m CE90. Positional errors are greater for greater nadir angles and at the locations with low accuracy of the SRTM DEM, which is used for orthorectification. For more details this report can be checked.

Once order is successfully completed, the ordered data are available in one of TPDI collections. The tiles in the collection will correspond to WorldView scenes. To access the data, the ID of this collection is needed. Accessing WorldView data is like accessing BYOC data. All processing and filtering options listed there can be used. The settings specific for accessing WorldView data are listed below.

Table 19: Endpoint locations WorldView

Service	Notes
https://services.sentinel-hub.com/	Contains the data purchased by individual user

To filtering options the id of the TPDI collection needs to be used into which your WorldView data was delivered as a value of parameter input.data.dataFilter.collectionId in the process API requests. See BYOC data access for more information. The bands and data which can be set in the evalscript input object are explained below. Any string listed in the column Name can be an element of the input.bands array in evalscript.

Table 20: Available band and data

Name	Description	Resolution
Blue	Blue, 450 - 510 nm	2m
Green	Green, 510 - 580 nm	2m
Red	Red, 630 - 690 nm for WV02 and WV03, 655 - 690 nm for GE01 and WV04	2m
NearIR1	Near Infrared, 770 - 895 nm for WV02 and WV03, 780 - 920 nm for GE01 and WV04	2m
PAN	Panchromatic, 450 - 800 nm	0.5m
dataMask	The mask of data/no data pixels (more).	N/A*

Data values for each band in your custom script are presented in the default units as specified in the table below. The Source Format specifies how and with what precision the digital numbers from which the unit is derived are encoded. The Typical Range indicates what values are common for a given band and unit, however outliers can be expected. For WorldView bands, DN (digital numbers) are the default and only unit. Reflectance values can be obtained using the simple formula: reflectance = DN / 10000.

Table 21: Units

Band	Unit	Source Format	Typical Range	Note
Optical bands	DN	UINT16	0 - 4000	Highly reflective pixels can have values above 10000.
dataMask	N/A	Boolean	0 - no data	

All mosaicking types are supported. The examples can be seen here[15].

[15] https://docs.sentinel-hub.com/api/latest/data/maxar/world-view/examples/

3 Third party data ordering

In this chapter, we will show you a step-by-step tutorial on how to search and order data from third-party providers such as PlanetScope or Pléiades using our Sentinel Hub API with Requests Builder.

To get commercial data, you need to select the Billing section of the configuration utility, where you can find and buy the commercial data packages you need. Discounts are available for bulk orders, and it is possible to get commercial data sponsored for research or pre-commercial use by submitting a proposal to the resource network.

To try out commercial data, we took some data in advance to work with. To work with the test samples, an allotment 0 must be set up on the account. The number of square kilometers available is called your quota. When you make a request to see the quota, the response will indicate how much total quota (km^2) is available, how much has been used, and how much is left, for each of the constellations you have purchased. When the quota is exhausted, you can no longer make requests and must purchase additional quota.

3.1 Order Commercial Data with Requests Builder

You can easily request third party data with our Requests Builder tool that supports all TPDI functionalities. Just log

in with your Sentinel Hub user credentials, select the *3RD PARTY DATA* mode at the top of the interface and you can start building your requests. To try out the test examples in requests builder, log in and click on PLANET or AIRBUS links in the banner on top. This will set the request to the test example, and you will be able to run it cost free. However, the test examples only work, if you do not change any of the parameters of the request. If you do, it will cost you your quota, and if you don't have quota, it won't work.

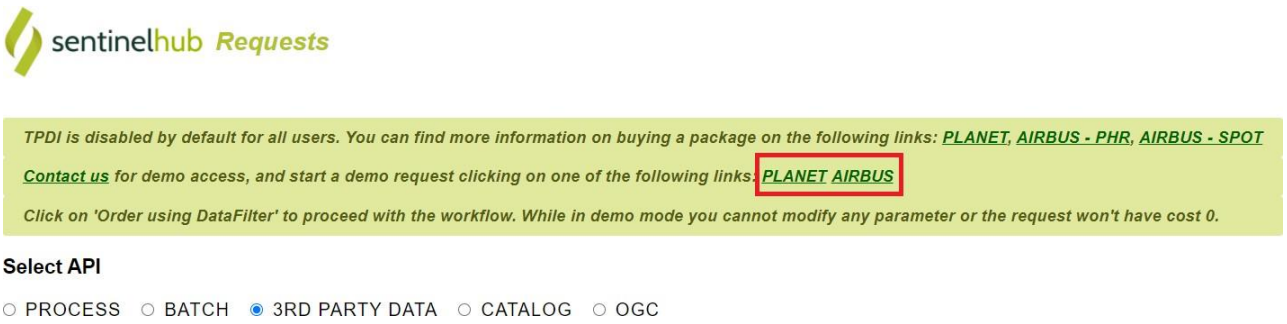


Figure 1: Request to select API for 3rd party data

Use convenient in-built features of the Requests Builder like time range selection and an interactive map for a straightforward and user-friendly selection of AOIs.

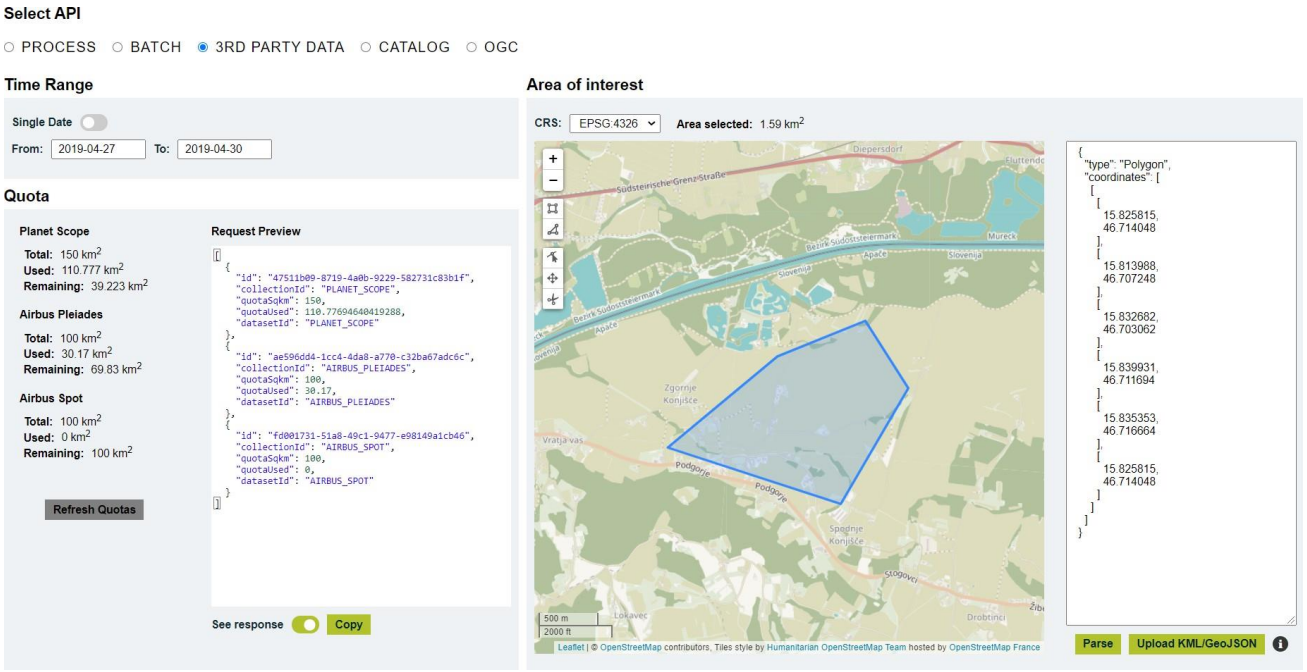


Figure 2: Image how to select time range and quota

3.1.1 Search for Data

After having selected a time range and AOI for the request, you need to specify the third party data provider via the dropdown menus on the left. In the case of Planet Scope, you will have to provide your Planet API Key to query for available datasets. In the example requests, you don't need a planet API key.

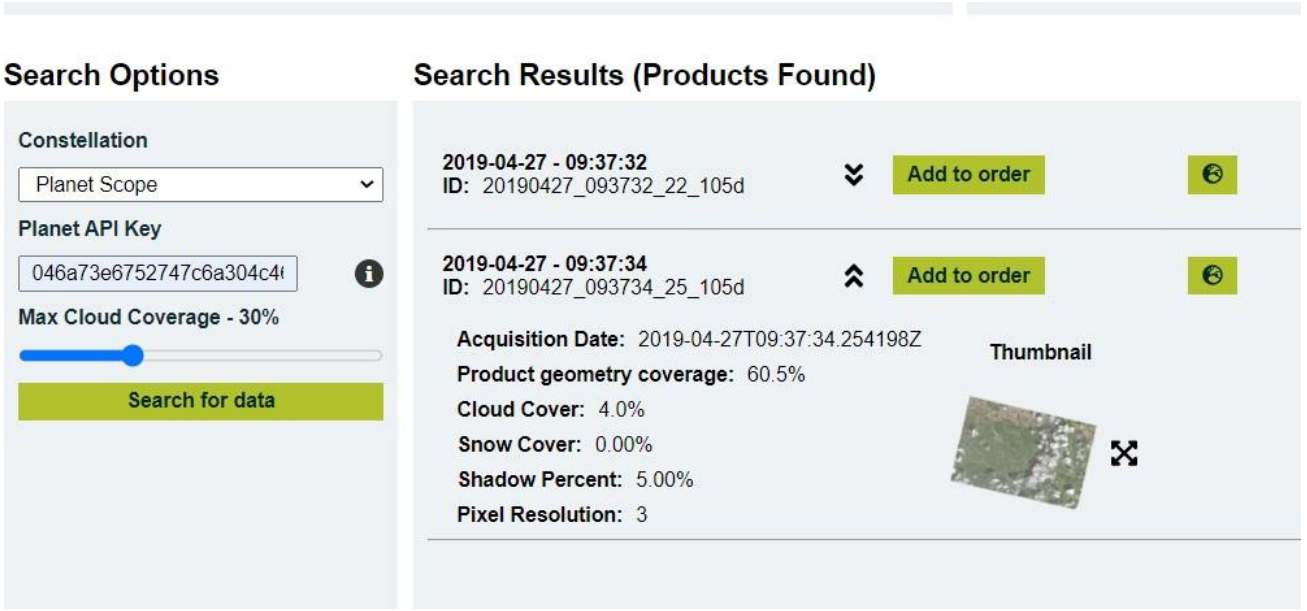


Figure 3: Search options

After setting the maximum cloud coverage and searching for data, you will get a list of data products available. In the name, you can see the acquisition time of the product, and the product ID.

Clicking on the little green map icon on the right of the product, the product area (green) will be displayed on the map, covering your geometry (blue).

As you can see, the product area can be much bigger than your geometry. The product will be clipped to your geometry. It's possible that the product you chose does not cover your geometry fully. To check the coverage, see Product geometry coverage percentage. To see how the product actually looks like, expand the thumbnail to examine it.

3.1.2 Order data

To add the products to your order, you need to click on Add to order button. This will add the product ID to your order in the panel below.

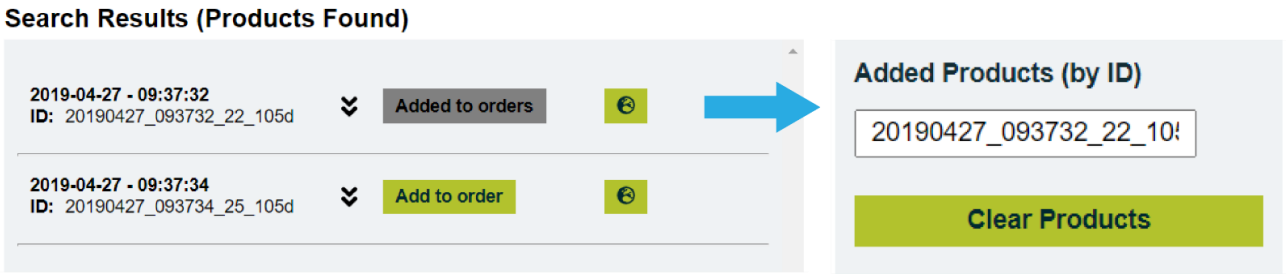


Figure 4: Adding the product ID to order

In the Order Options panel, first, choose the name of your order. Next, choose the order type.

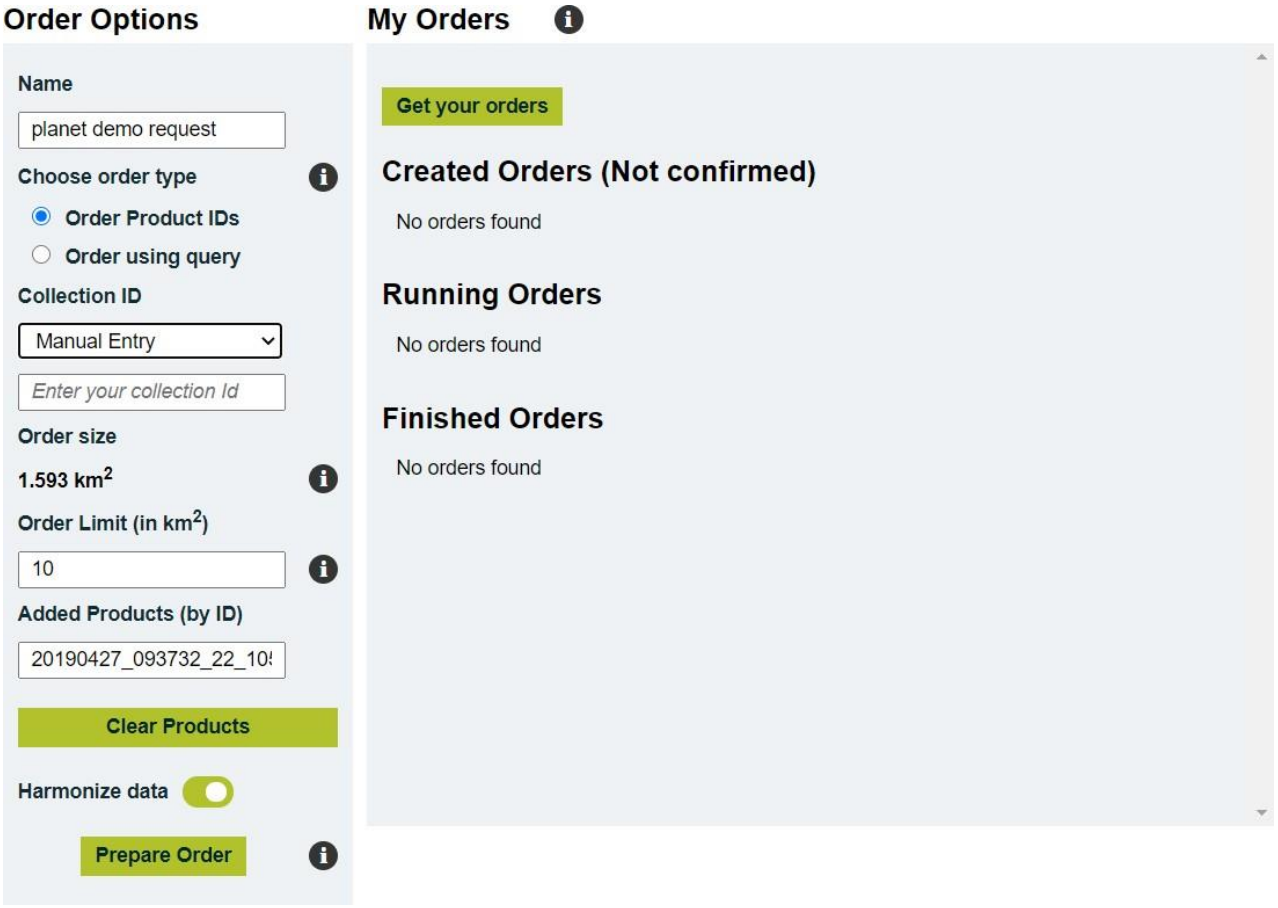


Figure 5: Choose the name of the order

3.1.3 Order types

Order Products IDs requires for you to search for data and add products to your order by manually clicking on the Add to Order button, as displayed above. You can add as many products as you'd like, but only for one geometry per order. If you redraw your geometry, previously added products will be removed. this is a Requests Builder specific limitation - in Postman, you should be able to make multipoligon orders. Order using query option will automatically add all the available products within your selected time range to your order, so you don't have to search for data and add them manually.

3.1.4 Order Size and Limit

The Order size gives you an estimate of your order size (the quota, you are about to use). In case you only order a single product, this will equal the area of your geometry in km^2. If you order 2 products, this will equal double your geometry area, unless one of the products does not have full coverage. Ordering by query, your quota can easily be very high, as you're ordering many products, multiplying your area in km^2, resulting in a large quota. This is why order limit is useful - it is a safeguard you set in place, to prevent accidentally making orders too large. If your order is larger than your set order limit, you won't be able to click the Place Order button.

3.1.5 Collection ID

Before ordering, think about in which collection you would like your data to be ingested. You can choose to leave this field empty and create a new collection, or you can select one of your existing collections from the dropdown menu.

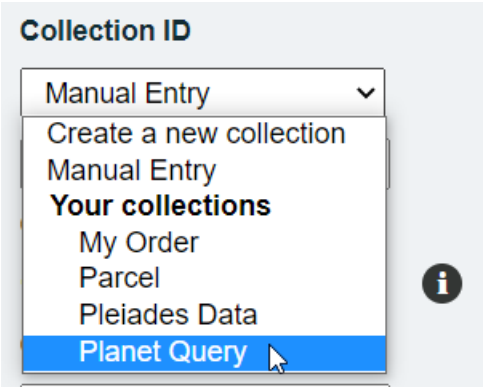


Figure 6: Collection ID

In general, it's advisable that you have one collection for a single constellation - one for PlanetScope data, one for Pléiades, and one for SPOT data. Each time you ingest a product, you ingest it into the same collection for that constellation, so that your collection will include all your tiles for that constellation. It's up to you how to organize your collections; you can also create new collections, rename them, delete them, and copy tiles to other collections, to have full control over them.

3.1.6 Prepare and Confirm the Order

The Prepare Order button will prepare your order, but not yet execute it. At this stage, no quota will be subtracted. When you click on it, the order will appear in the Created Orders (Not Confirmed) section of My Orders on the right. You can see the quota the order will subtract, if you confirm the order, next to Size. The status of the order is set to CREATED, which means that the order was created, but not yet confirmed.

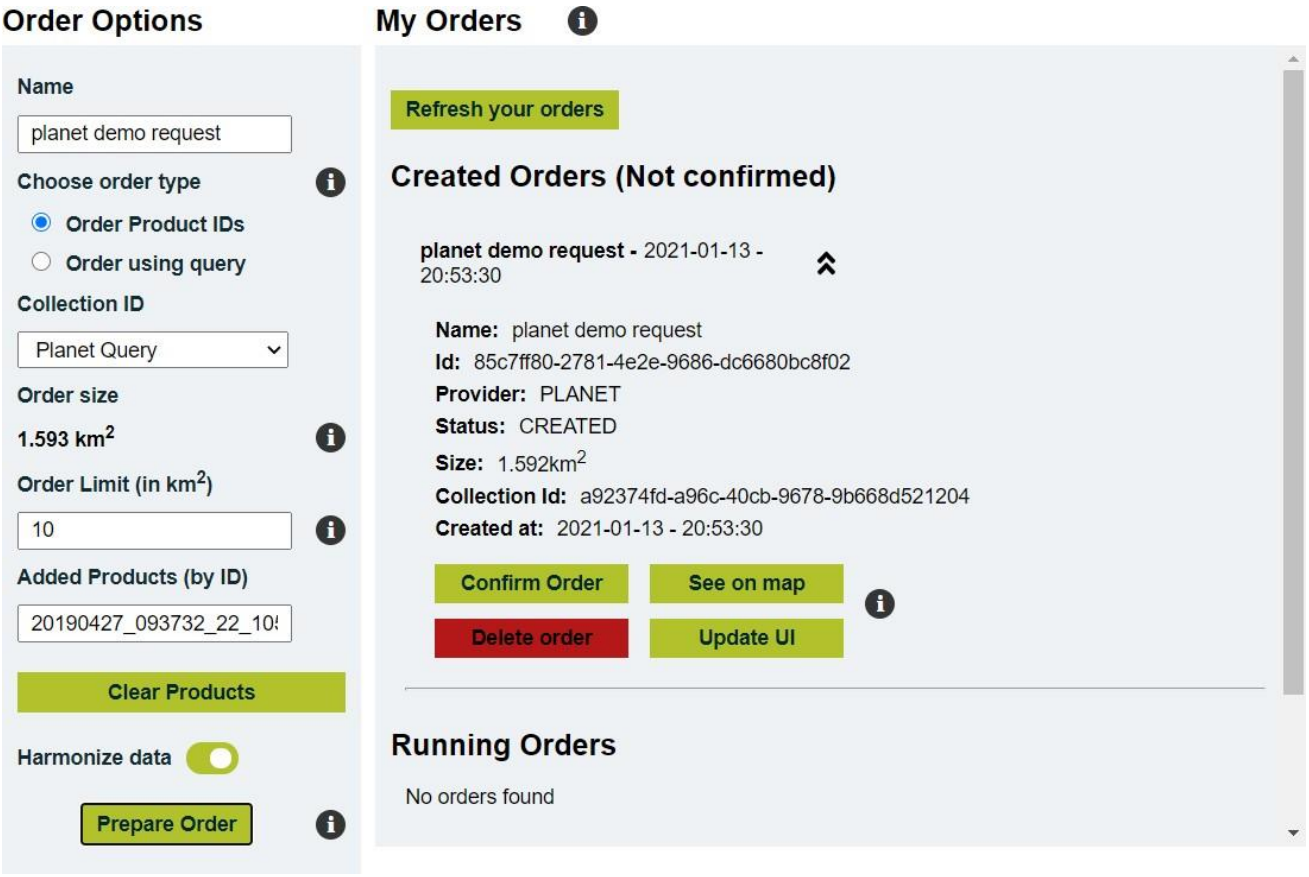


Figure 7: Preparing and confirming order

When you click on Confirm Order, the following will happen:

- Your quota will be subtracted (unless you're working with test examples)
- A new collection will appear in your Dashboard, if you chose to create a new collection
- The order will move to the Running Orders section
- Status will change to RUNNING

At this stage, the tiles are not yet ingested. You can check the status of all your tiles by clicking on Get Deliveries button.

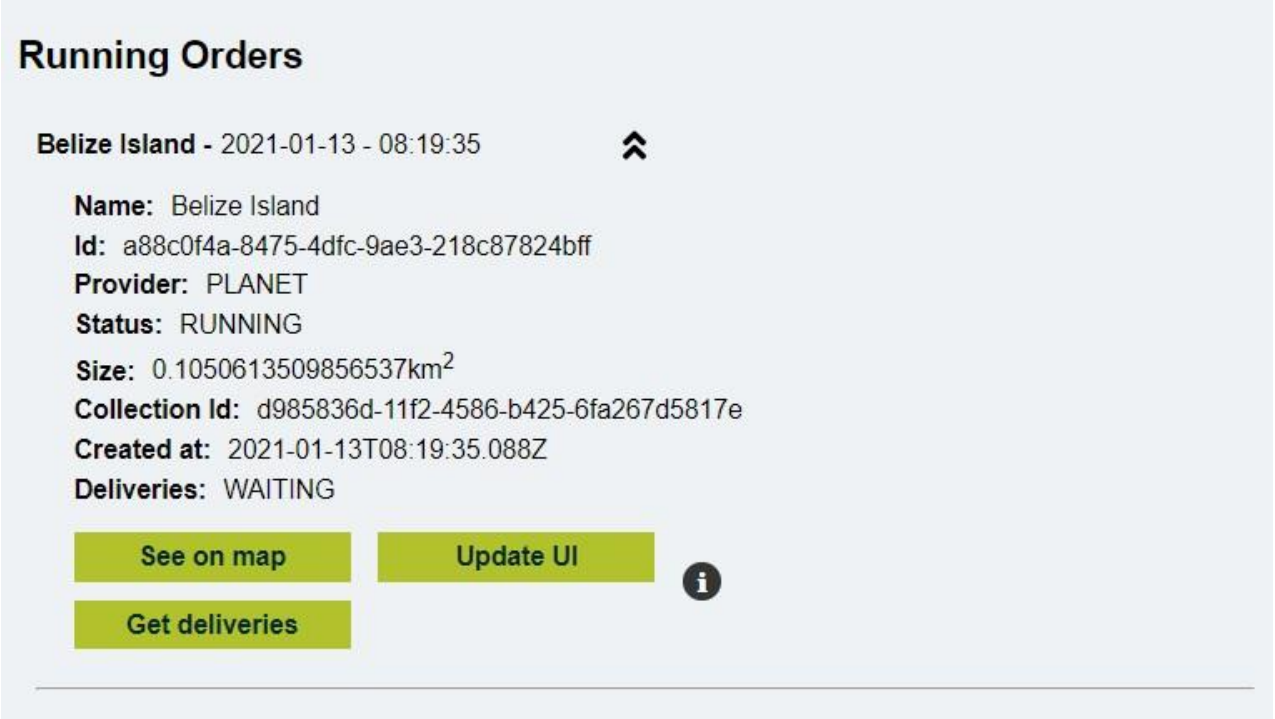


Figure 8: Running orders

When the tiles are ingested, the order will move to the Finished Orders section. At this stage, the tiles were successfully ingested into your collection and the order status will say DONE. You might have to click Refresh your Orders to see the order move. All your finished orders will be stored here if you ever want to revisit them (unless you delete them).

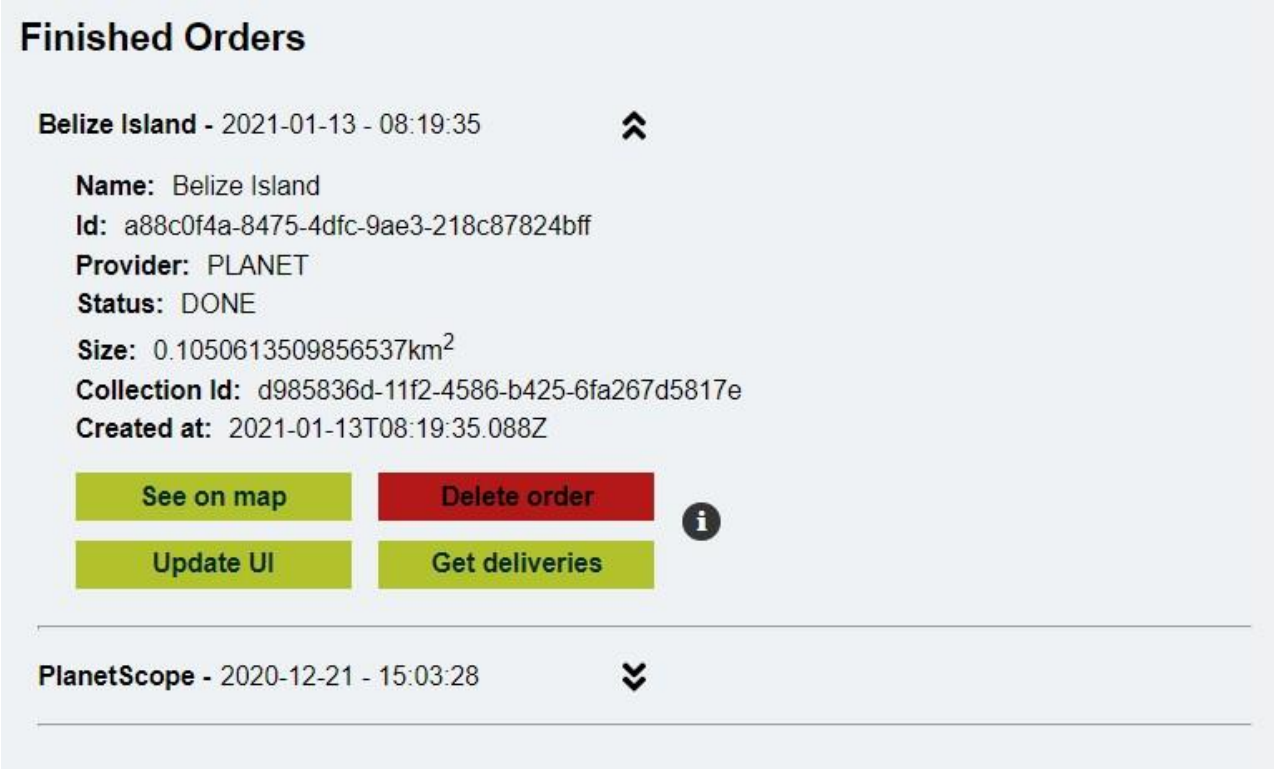


Figure 9: Finished order

3.1.7 Request Previews

Note that requests builder has the request previews next to Quota, Search and Order sections. You can preview the request, that is being sent, and toggle between the request preview and the response.

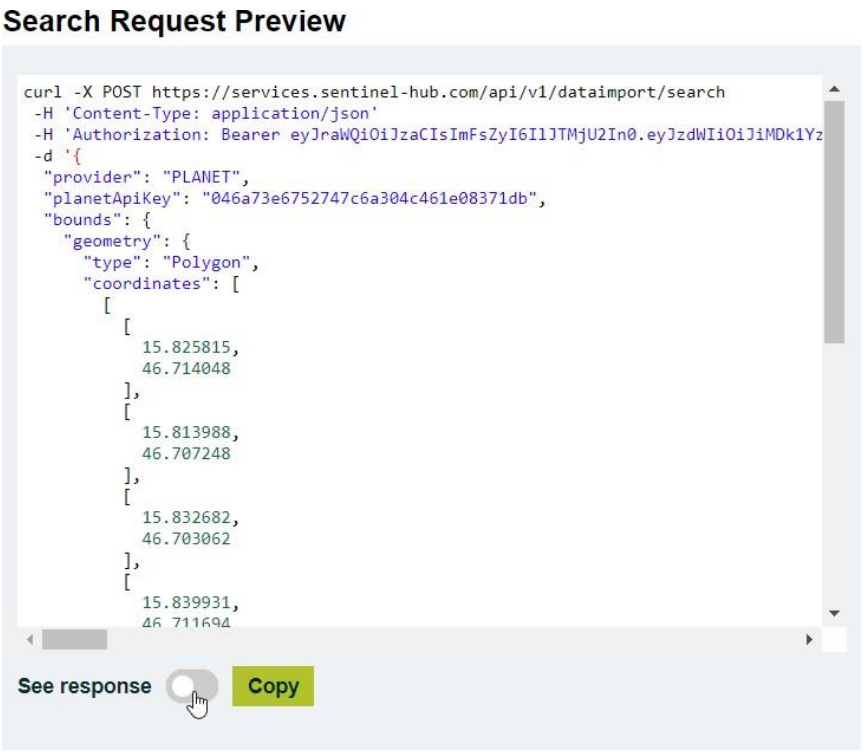


Figure 10: Search request preview

Now that you have an idea of how to order third party data with our Requests Builder, see for yourself how convenient the ordering process is and give it a try. If you prefer to use Postman you could even copy the curl-request from the *Request Preview* panel and import your built request into Postman.

3.2 Visualize Data in EO Browser

You can also visualize your purchased third party data directly in EO Browser by following the ensuing steps. Create a new configuration and connect the BYOC collection Go to the Configuration Utility section in your personal dashboard.

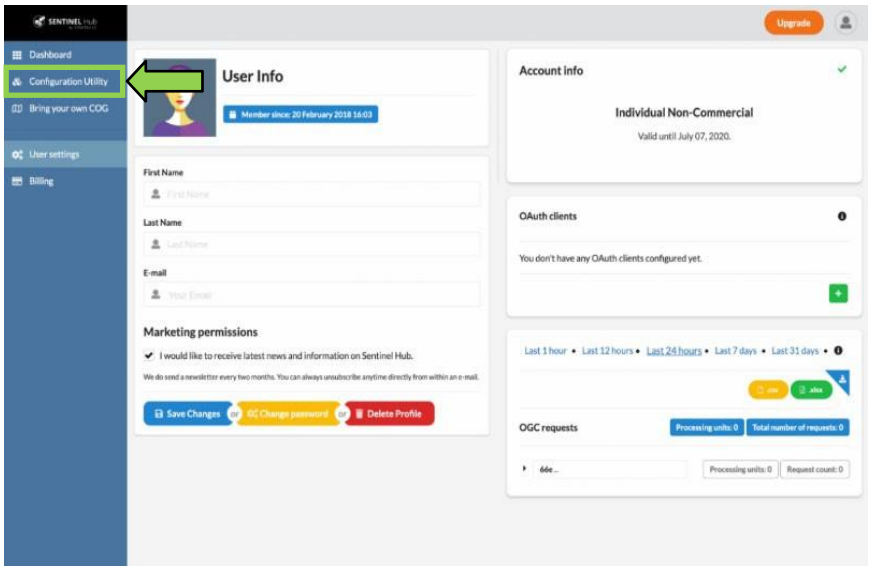
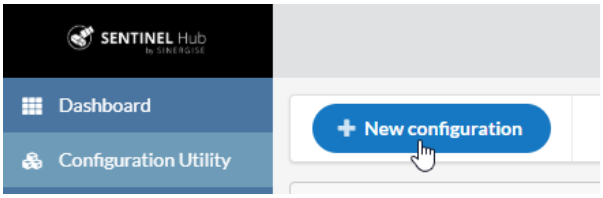
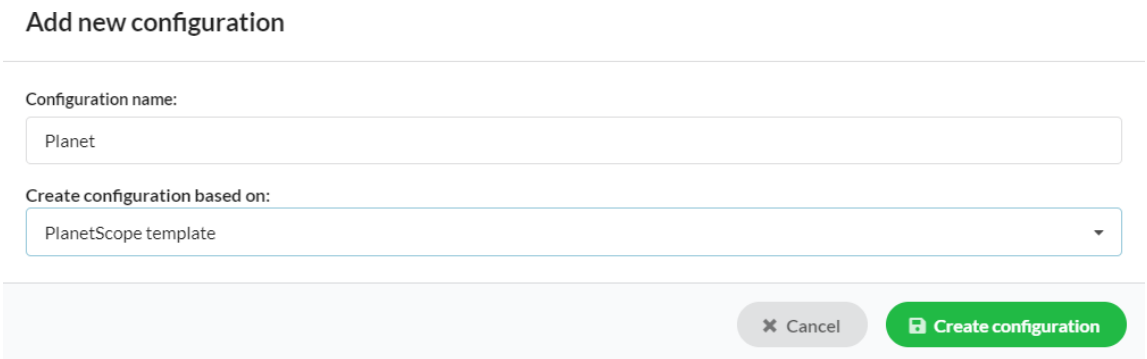


Figure 11: Configuration utility

Click New configuration.



Add a name and for easiest workflow, select the configuration template, that matches your constellation (e.g., PlanetScope Template). When done, click Create configuration.



Using a configuration template, a couple of chosen layers will be already created for you.

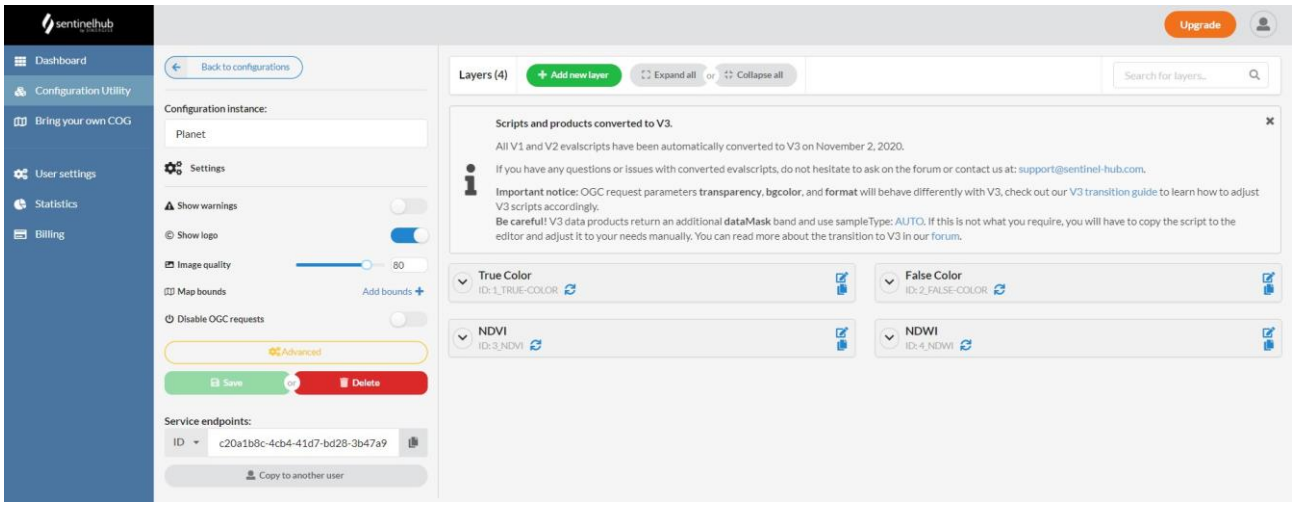


Figure 12: Using a configuration template

All the layers will have the wrong collection ID, consisting of a long string of zeroes. Replace it with the ID of the BYOC collection that contains your Planet data (in the Bring your own COG section of your dashboard). This will make the layers ready for use without the need to search for scripts or create new layers. Don't forget to save your layers.

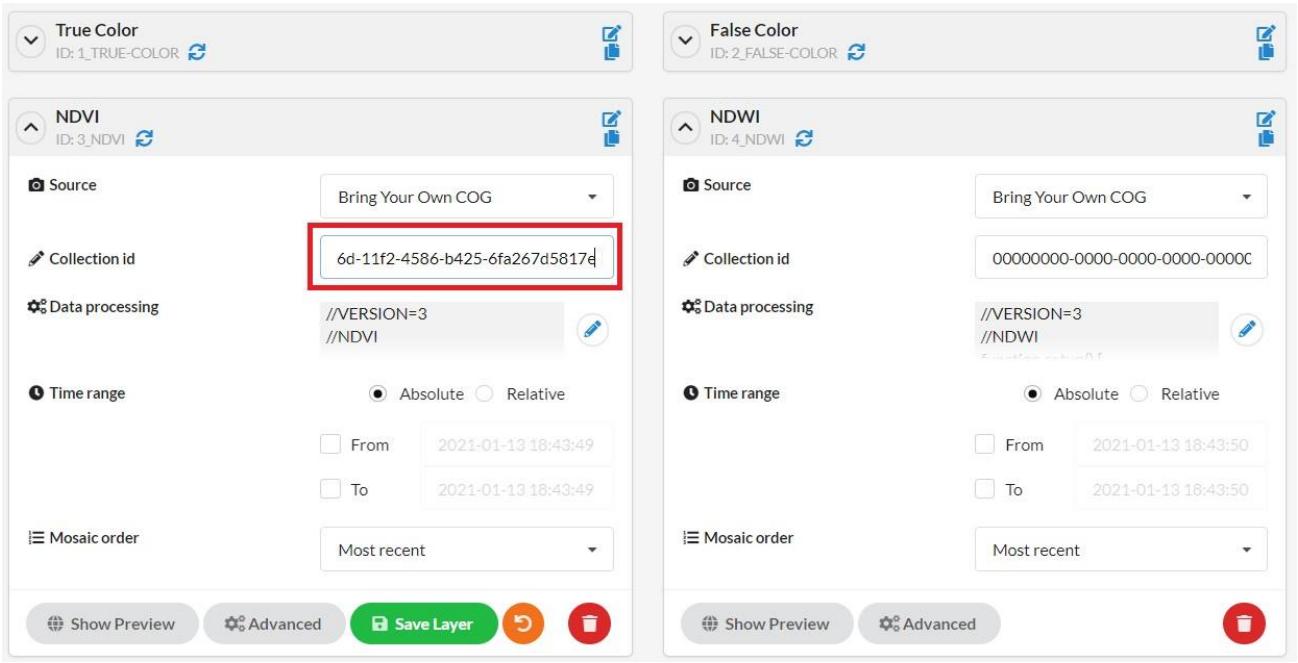
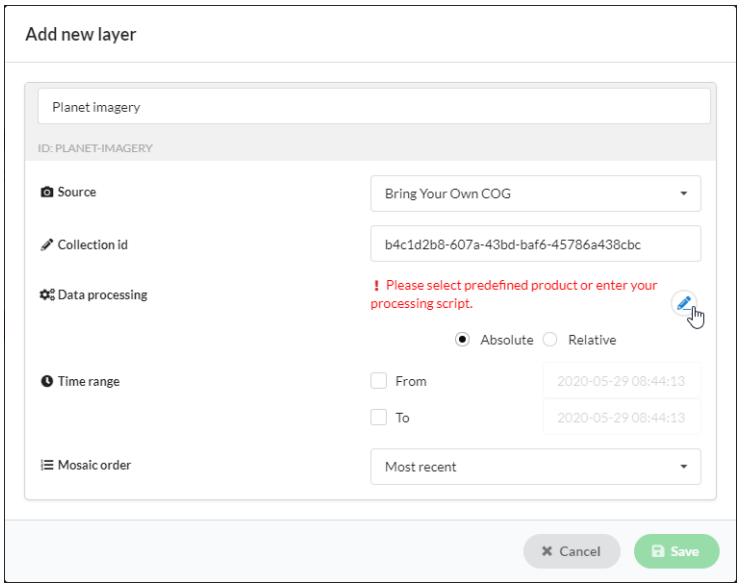


Figure 13: BYOC collection that contains Planet data

If you would like to add additional layers, click on Add Layer. Add a name for the layer, as the *Source* select Bring Your Own COG and insert the collection ID. Then click on the editing symbol in *Data processing* as shown below.



To find the script to paste in, check the PlanetScope section of our custom script repository (there's also an Airbus Pléiades section, with scripts, that work the same for SPOT as well). Just open one of the scripts, click on show script on top, and copy paste it into the script editor.

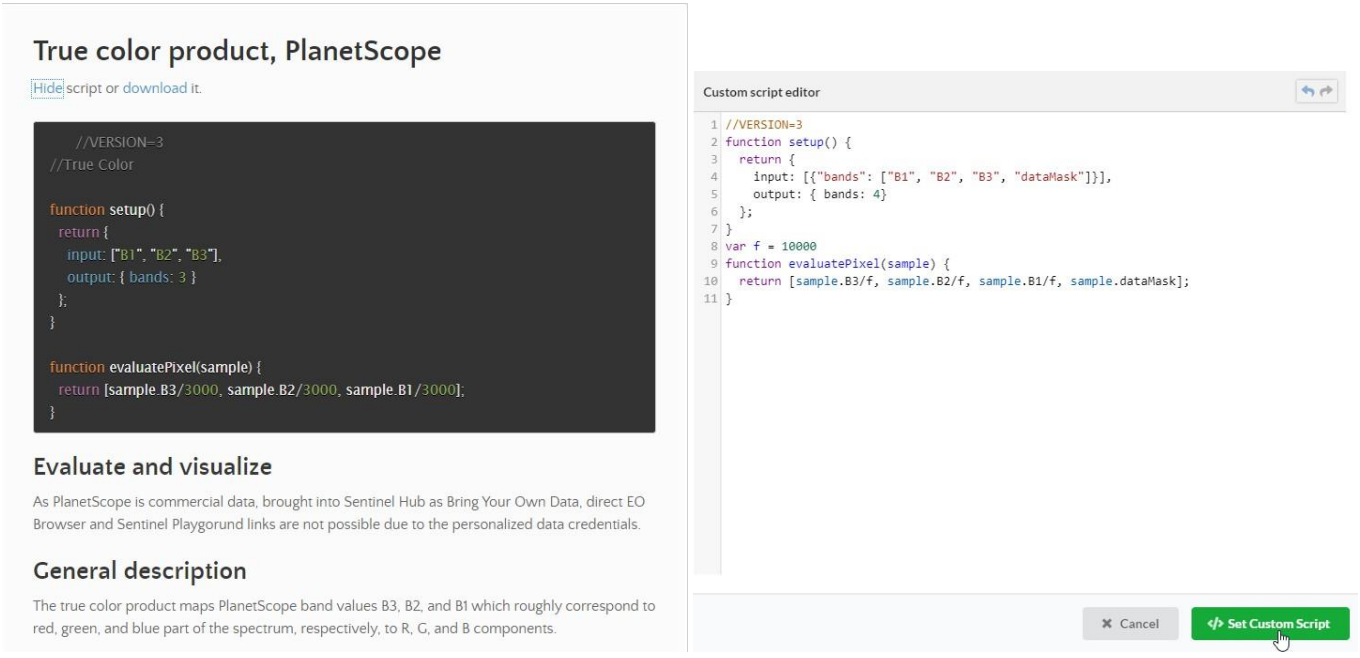


Figure 14: PlanetScope section of our custom script repository

Save the layer by clicking on the Save button. Change any other options in the configuration to your liking and save it.

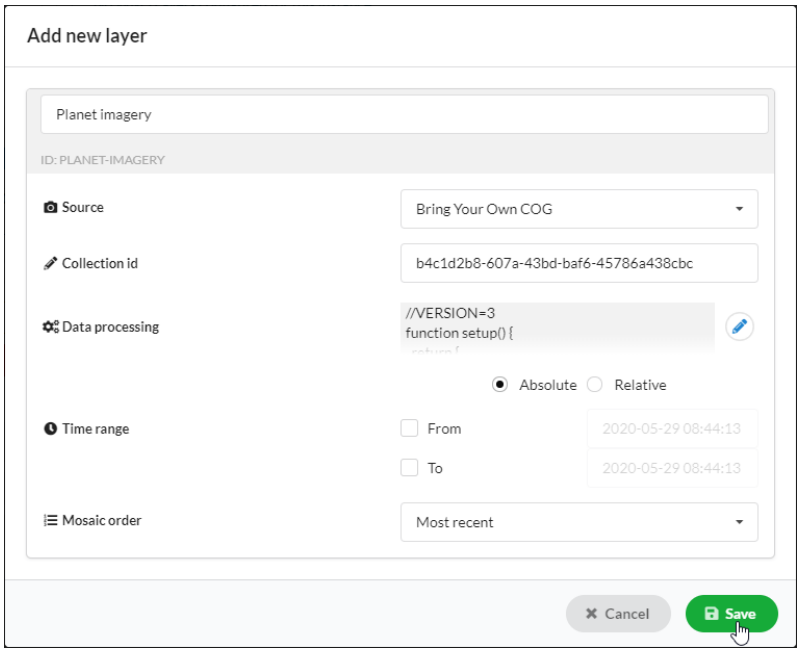
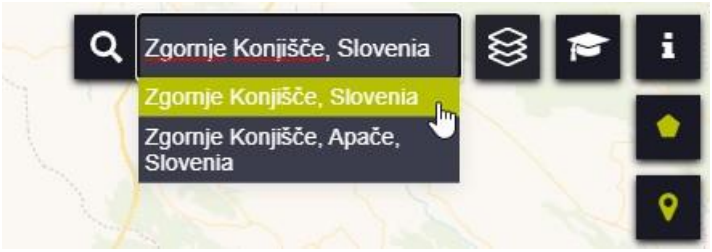


Figure 15: Saving layer

Display imagery in EO Browser

Log into your Sentinel Hub account on EO Browser and zoom to the area, where your data is ingested (if you're working with the example requests, search for "Zgornje Konjišče, Slovenia" using the search bar in the top right corner.)



On the bottom of the Search tab, select the configuration name you created in the previous step as the theme in the drop-down list.

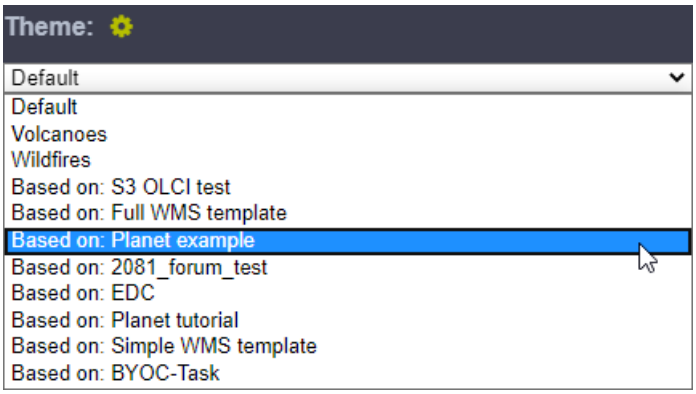


Figure 16: Select the configuration name

Adjust the time range according to the acquisition date of the ingested image tiles, which is 27 April 2019 and click Search (left), then Visualize one of the results (right).

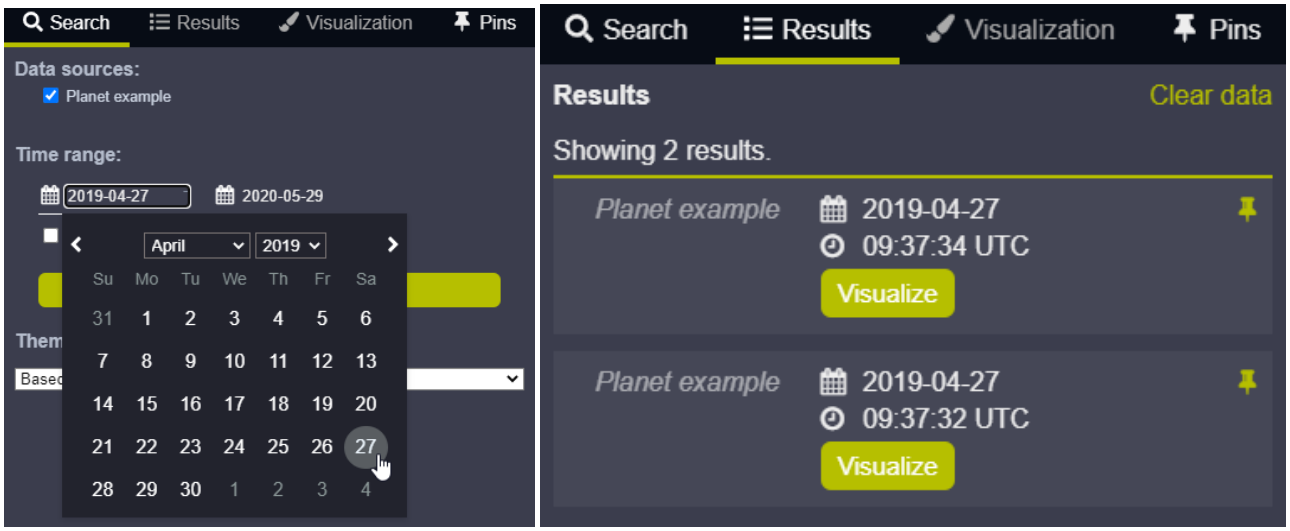


Figure 17: Adjust the time range

Zoom in until you can see the planet image on the map in EO Browser.

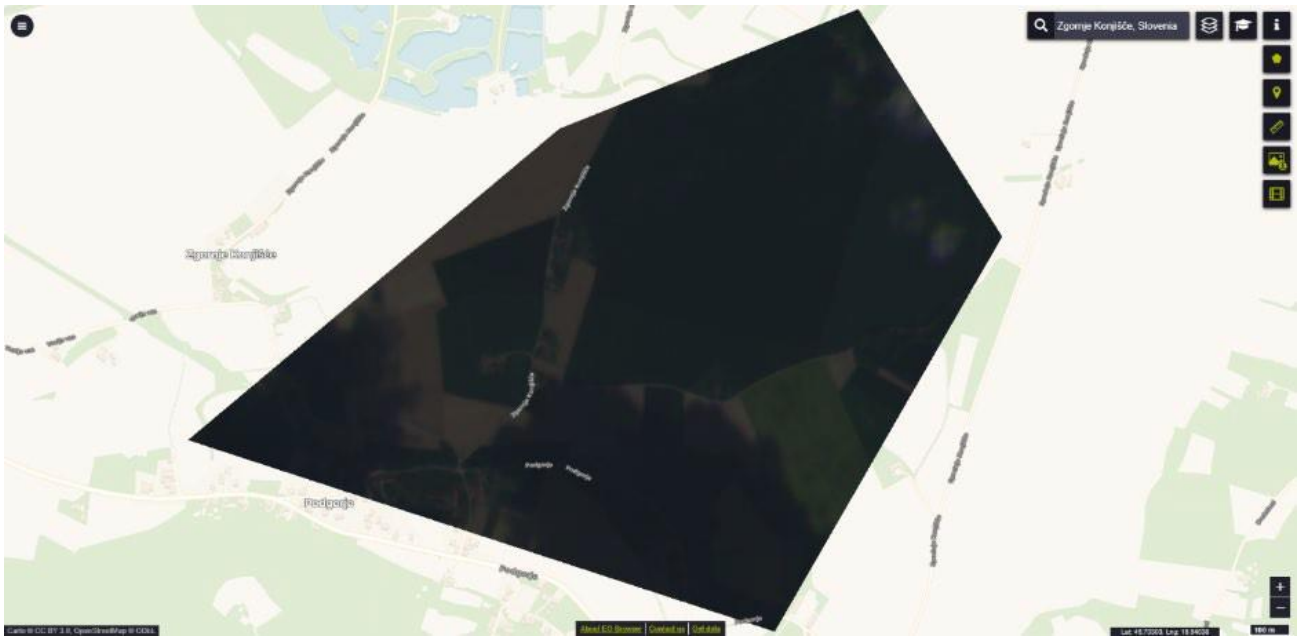


Figure 18: Planet image

3.3 Accessing data with sentinel-hub and eo-learn

Access to third party data, obtained through Sentinel-Hub, is possible also with sentinelhub-py (a Python library for Sentinel-Hub) and with eo-learn (collection of open source Python packages bridging EO data with ML tools). The following chapter will show a few examples of retrieving and processing VHR data with the two tools.

3.3.1 Planet data

We define the bounding box of the request first, as shown in Figure 19.

```
# Bbox
dakar_large_bbox = [249984, 1636430, 251910, 1638457]

# Bbox EPSG number
dakar_epsg = 32628
```

```
# Plot the geometry on a map
IPython.display.GeoJSON(BBox(dakar_large_bbox, crs=dakar_epsg).transform(4326).get_geojson())
```

Figure 19: Bounding box for the AOI for the PlanetScope data request.

The code to retrieve data over this AOI, for a specified time window, is shown below:

```
from eolearn.core import EOPatch, FeatureType
from eolearn.io import SentinelHubEvalscriptTask

ps_evalscript = """
//VERSION=3
function setup() {
  return {
    input: ["B1", "B2", "B3", "B4", "UDM", "dataMask"],
    output: [
    {
        id: "planetscope_bands",
        bands: 5,
        sampleType: "UINT16"
    },
    {
        id: "masks",
        bands: 2,
        sampleType: "UINT8"
    }]
  };
}

function evaluatePixel(sample) {
  return {
      "planetscope_bands": [sample.B1, sample.B2, sample.B3, sample.B4],
      "masks": [sample.UDM, sample.dataMask]
      };
}
"""

ps_data = SentinelHubEvalscriptTask(
    features = [
        (FeatureType.DATA, 'planetscope_bands'),
        (FeatureType.MASK, 'masks')
    ],
    evalscript = ps_evalscript,
    data_collection = DataCollection.define_byoc(planet_collection),
    resolution = (3,3)
)

eop = ps_data.execute(
    bbox=BBox(dakar_large_bbox, crs=dakar_epsg),
    time_interval=('2017-04-21', '2017-04-24')
)
```

This simple example retrieved all the PlanetScope bands and Unused Data Mask (UDM), and data Mask from Sentinel Hub. From here on eo-learn can be used to prepare a typical workflow (e.g., calculating features,

sampling, etc.) can be used. Figure 20 shows the true color composites of the two PlanetScope images available in this time interval.

Figure 20: Two PlanetScope acquisitions with their corresponding Unusable Data Masks (UDM).

Similar code can be constructed for all the VHR data providers presented in this document. The rest of this section will give an example for each third party data, with some changes to show the capabilities of the services.

3.3.2 SPOT data

In this example we will be using sentinelhub-py library to directly construct a Process API request. We will request for data over a geometry, shown in Figure 21. The code will allow us to plot a change in the Normalized Difference Water Index (NDWI) between observation taken in 2011 and another one in 2021, shown in Figure 22.

```
# Plot the geometry on a map
IPython.display.GeoJSON(dakar_geom.transform(4326).get_geojson())
```

Figure 21: Geometry of the request for SPOT data.

```
# Define DataCollection
spot_col = DataCollection.define_byoc(spot_collection)

# Evalscript to return NDWI
ndwi_eval = """
//VERSION=3
function setup() {
  return {
    input: ["B1", "B3"],
    output: { bands: 1, sampleType: "FLOAT32" },
  };
}

function evaluatePixel(sample) {
  let ndwi = (sample.B1 - sample.B3) / (sample.B1 + sample.B3)
  return [ndwi];
}
"""

# Build request for the first time step
request_t1_ndwi = SentinelHubRequest(
    evalscript=ndwi_eval,
    input_data=[
        SentinelHubRequest.input_data(
            data_collection=spot_col,
            time_interval=('2012-10-17')
        )],
    responses=[SentinelHubRequest.output_response('default', MimeType.TIFF)],
    geometry=dakar_geom,
    resolution=(6, 6)
)
```

```
# Build a request for the second time step
request_t2_ndwi = SentinelHubRequest(
    evalscript=ndwi_eval,
    input_data=[
        SentinelHubRequest.input_data(
            data_collection=spot_col,
            time_interval=('2021-02-25')
        )],
    responses=[SentinelHubRequest.output_response('default', MimeType.TIFF)],
    geometry=dakar_geom,
    resolution=(6, 6)
)

# Calculate NDWI
ndwi_t1 = request_t1_ndwi.get_data()[0]
ndwi_t2 = request_t2_ndwi.get_data()[0]

# Compute change between two dates
ndwi_change = ndwi_t2 - ndwi_t1
```

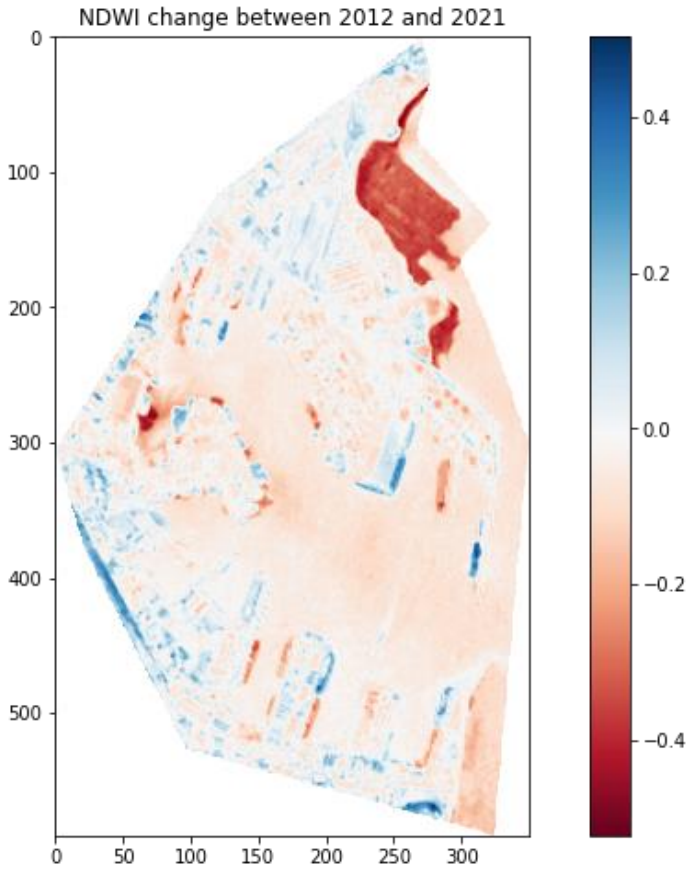


Figure 22: NDWI change between 2012 and 2021, from SPOT data.

3.3.3 Pléiades data

In this example we will be using Sentinel-Hub to retrieve pansharpened Pléiades true color image over Mbao industrial area in Dakar, Senegal, as shown in Figure 23. The pansharpened image is shown in Figure 24.

```
# Plot the geometry on a map
IPython.display.GeoJSON(mbao_geom.transform(4326).get_geojson())
```

Figure 23: Geometry of requested Pléiades data.

```
pleiades_pansharpen_evalscript = """
//VERSION=3
function setup() {
  return {
    input: ["B0", "B1", "B2", "PAN"],
    output: { bands: 3 }
  }
}

function evaluatePixel(samples) {
  let sudoPanW = (samples.B0 + samples.B1 + samples.B2) / 3
  let ratioW = samples.PAN / sudoPanW
  let red = 2.5 * samples.B2 * ratioW
  let green = 2.5 * samples.B1 * ratioW
  let blue = 2.5 * samples.B0 * ratioW
  return [red/10000, green/10000, blue/10000]
}
"""

# Build request for the first time step
pleiades_request = SentinelHubRequest(
    evalscript=pleiades_pansharpen_evalscript,
    input_data=[
        SentinelHubRequest.input_data(
            data_collection=DataCollection.define_byoc(pleiades_collection),
            time_interval=('2019-12-24')
        )],
```

```
    responses=[SentinelHubRequest.output_response('default', MimeType.TIFF)],
    geometry=mbao_geom,
    resolution=(1, 1)
)

pleiades_data = pleiades_request.get_data()[0]
```

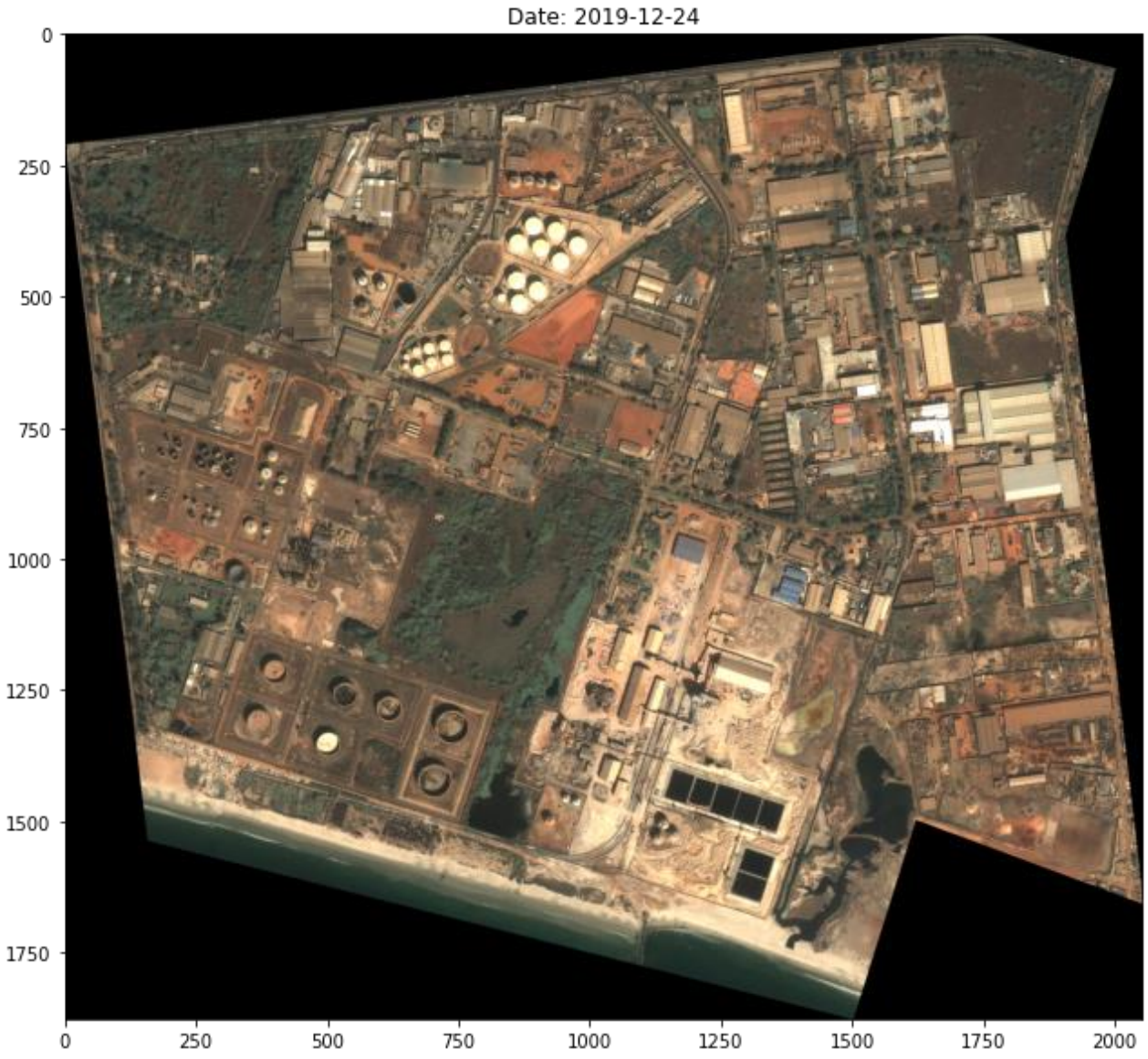


Figure 24: True colour Pléiades imagery from 2019, pan-sharpened to 1 m.

3.3.4 Worldview data

In the following example, we will set our AOI to a bounding box in Keur Ndiaye Lo, north of Rufisque, shown in Figure 25.

```
# Plot the geometry on a map
IPython.display.GeoJSON(BBox(Keur_Ndiaye, crs=dakar_epsg).transform(4326).get_geojson())
```

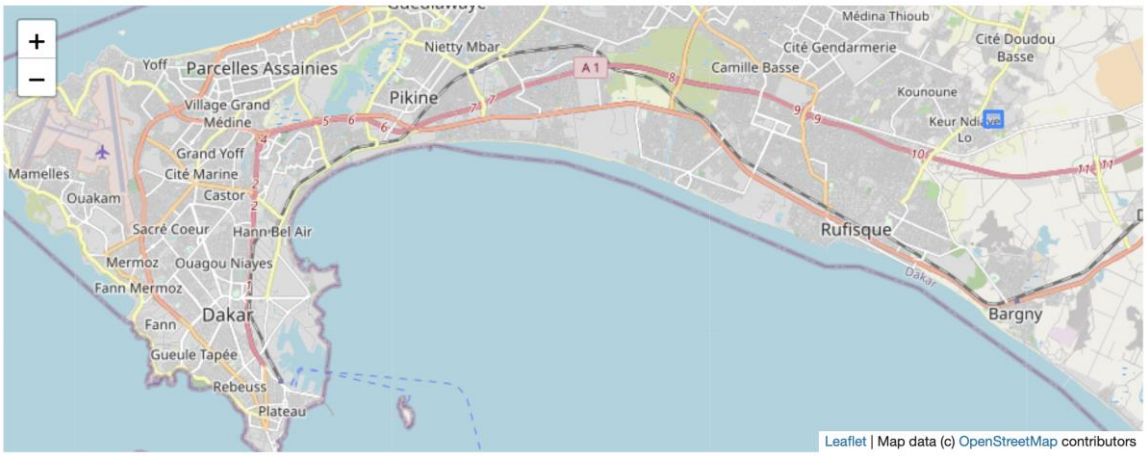


Figure 25: Bounding box for request of WorldView data in upper right part of the image.

The code below uses eo-learn to retrieve all available data in the period from 2013 to 2021. The resulting data can be used to produce Figure 26, which shows how urban area grew in the given period.

```
worldview_evalscript = """
//VERSION=3
function setup() {
  return {
    input: [{
      "bands": ["Red", "Green", "Blue", "NearIR1", "PAN", "dataMask"]
    }],
    output: [{
      id: "pseudo_pan",
      bands: 3
    },
    {
      id: "is_data",
      bands: 1
    }]
  }
}

function evaluatePixel(samples) {
    let sudoPanW = (samples.Red + samples.Green + samples.Blue + samples.NearIR1 ) / 4
    let ratioW = samples.PAN / sudoPanW / 10000 * 2.5
    let val = [samples.Red * ratioW,
               samples.Green * ratioW,
               samples.Blue * ratioW]
    return { "pseudo_pan": val, "is_data": [samples.dataMask] }

}
"""
```

```
worldview_data = SentinelHubEvalscriptTask(
    features = [
        (FeatureType.DATA, 'pseudo_pan'),
        (FeatureType.MASK, 'is_data')
    ],
    evalscript = worldview_evalscript,
    data_collection = DataCollection.define_byoc(maxar_collection),
    resolution = (0.5,0.5)
)

wv_eop = worldview_data.execute(
    bbox=BBox(Keur_Ndiaye, crs=dakar_epsg),
    time_interval=('2013-02-26', '2021-04-09')
)

fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(25,15))

for idx, ax in enumerate(axes.flatten()):
    if idx < len(wv_eop.timestamp):
        ax.imshow(wv_eop.data['pseudo_pan'][idx])
        ax.set_title(wv_eop.timestamp[idx].isoformat(), fontsize=18)
    else:
        ax.axis('off')
```

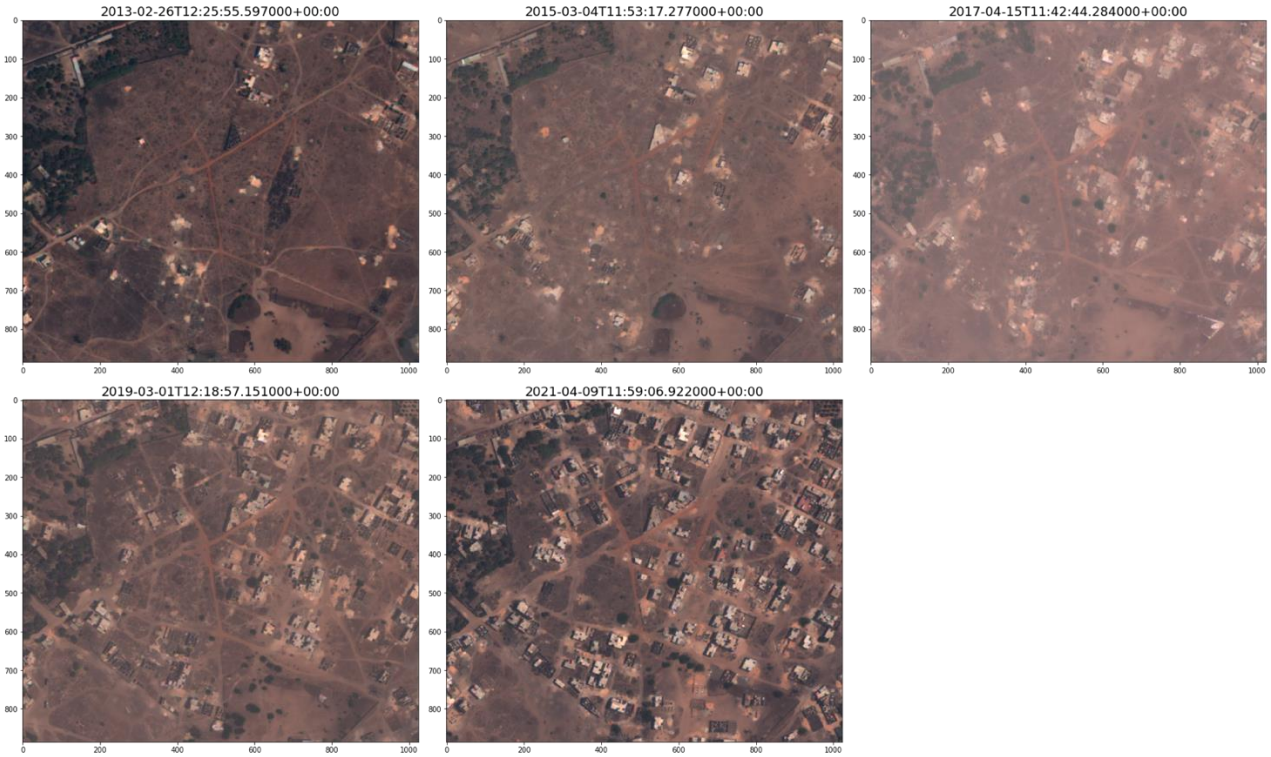


Figure 26: WorldView data shows how the urban area has changed through time.

4 Conclusion

Sentinel Hub supports a plethora of data sources. Besides the open datasets (e.g., Sentinels, Landsat and similar), commercial VHR data can now be used seamlessly within GEM use-cases. New data gateways have been developed that allow very high-resolution data to be read in via Sentinel Hub. Supported VHR sources are:

- PlanetScope
- SPOT
- Pléiades
- WorldView.

The deliverable describes the capability to purchase, on-demand, high-resolution data from listed providers. Data is automatically ingested in Sentinel Hub and can be accessed with the same APIs as any other data within Sentinel Hub, creating Data Cubes, using Statistical API, etc.

The full list of data, available through Sentinel Hub, is maintained as part of documentation at https://docs.sentinel-hub.com/api/latest/data/.