
SentinelSat Documentation

Release 0.13

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Sentinelsat makes searching, downloading and retrieving the metadata of Sentinel satellite images from the Copernicus Open Access Hub easy.

It offers an easy-to-use command line interface

```
sentinelsat -u <user> -p <password> -g </path/to/search_polygon.geojson> --sentinel 2_
↪--cloud 30
```

and a powerful Python API.

```
from sentinelsat import SentinelAPI, read_geojson, geojson_to_wkt

api = SentinelAPI('user', 'password')
footprint = geojson_to_wkt(read_geojson('/path/to/search_polygon.geojson'))
products = api.query(footprint,
                     producttype='SLC',
                     orbitdirection='ASCENDING')
api.download_all(products)
```


Install `sentinelsat` through `pip`:

```
pip install sentinelsat
```

1.1 Tests

To run the tests on `sentinelsat`:

```
git clone https://github.com/sentinelsat/sentinelsat.git
cd sentinelsat
pip install -e .[dev]
py.test -v
```

By default, prerecorded responses to Copernicus Open Access Hub queries are used to not be affected by its downtime. To allow the tests to run actual queries against Copernicus Open Access Hub set the environment variables

```
export DHUS_USER=<your scihub username>
export DHUS_PASSWORD=<your scihub password>
```

and add `--vcr disable` to `py.test` arguments. To update the recordings use either `--vcr record_new` or `--vcr reset`.

1.2 Supported Python versions

Sentinelsat has been tested with Python versions 2.7 and 3.4+. Earlier Python 3 versions are expected to work as well as long as the dependencies are fulfilled.

1.3 Optional dependencies

The convenience functions `to_dataframe()` and `to_geodataframe()` require `pandas` and/or `geopandas` to be present.

Command Line Interface

Sentinelsat provides a CLI **sentinelsat** to query and download multiple or single images.

2.1 Quickstart

A basic search query consists of a search polygon as well as the username and password to access the Copernicus Open Access Hub.

```
sentinelsat -u <user> -p <password> -g <search_polygon.geojson>
```

For convenience and added security, there are two ways you can store your credentials and omit them from the command line call. You can set username, password and DHuS URL as environment variables.

```
export DHUS_USER="<user>"
export DHUS_PASSWORD="<password>"
export DHUS_URL="<api_url>"
```

Alternatively, you can add them to a file *.netrc* in your user home directory.

```
machine scihub.copernicus.eu
login <user>
password <password>
```

Environment variables take precedence over *.netrc*. The above command then becomes

```
sentinelsat -g <search_polygon.geojson>
```

Search areas (i.e. `search_polygon.geojson`) are provided as GeoJSON files, which can be created with [QGIS](#) or [geojson.io](#). If you do not specify a start and end date only products published in the last 24 hours will be queried.

Start and end dates refer to the acquisition date given by the `beginPosition` of the products, i.e. the start of the acquisition time.

2.1.1 Sentinel-1

Search and download all Sentinel-1 scenes of type SLC over a search polygon, in descending orbit for the year 2015.

```
sentinelsat -u <user> -p <password> -g <search_polygon.geojson> -s 20150101 -e_
↪20151231 -d \
--producttype SLC -q "orbitdirection=Descending" \
--url "https://scihub.copernicus.eu/dhus"
```

Download a single Sentinel-1 GRDH scene covering Santa Claus Village in Finland on Christmas Eve 2015.

```
sentinelsat -u <user> -p <password> -d --uuid a9048d1d-fea6-4df8-bedd-7bcb212be12e
```

or by using its filename

```
sentinelsat -u <user> -p <password> -d --name S1A_EW_GRDM_1SDH_20151224T154142_
↪20151224T154207_009186_00D3B0_C71E
```

2.1.2 Sentinel-2

Search and download Sentinel-2 scenes for January 2016 with a maximum cloud cover of 40%.

```
sentinelsat -u <user> -p <password> -g <search_polygon.geojson> -s 20160101 -e_
↪20160131 --sentinel 2 --cloud 40 -d
```

Download all Sentinel-2 scenes published in the last 24 hours.

```
sentinelsat -u <user> -p <password> -g <search_polygon.geojson> --sentinel 2 -d
```

2.2 sentinelsat

```
sentinelsat -u <user> -p <password> [OPTIONS]
```

Options:

-u	-user	TEXT	Username [required] (or environment variable DHUS_USER)
-p	-password	TEXT	Password [required] (or environment variable DHUS_PASSWORD)
	-url	TEXT	Define another API URL. Default URL is 'https://scihub.copernicus.eu/apihub/'.
-s	-start	TEXT	Start date of the query in the format YYYYMMDD.
-e	-end	TEXT	End date of the query in the format YYYYMMDD.
-g	-geometry	PATH	Search area geometry as GeoJSON file.
	-uuid	TEXT	Select a specific product UUID instead of a query. Multiple UUIDs can be separated by commas.
	-name	TEXT	Select specific product(s) by filename. Supports wildcards.
	-sentinel	INT	Limit search to a Sentinel satellite (constellation).
	-instrument	TEXT	Limit search to a specific instrument on a Sentinel satellite.
	-producttype	TEXT	Limit search to a Sentinel product type. List of valid product types can be found under producttype here.
-c	-cloud	INT	Maximum cloud cover in percent. (requires <code>--sentinel</code> to be 2 or 3)
-o	-order-by	TEXT	Comma-separated list of keywords to order the result by. Prefix '-' for descending order.
-l	-limit	INT	Maximum number of results to return. Defaults to no limit.
-d	-download		Download all results of the query.
	-path	PATH	Set the path where the files will be saved.
-q	-query	TEXT	Extra search keywords you want to use in the query. Separate keywords with comma. Example: 'producttype=GRD,polarisationmode=HH'.
-f	-footprints		Create geojson file search_footprints.geojson with footprints of the query result.
	-version		Show version number and exit.
-h	-help		Show help message and exit.

ESA maintains a [list of valid search keywords](#) that can be used with `--query`.

The options `--sentinel`, `--instrument` and `--producttype` are mutually exclusive and follow a hierarchy from most specific to least specific, i.e. `--producttype` > `--instrument` > `--sentinel`. Only the most specific option will be included in the search when multiple ones are given.

Searching by name supports wildcards, such as `S1A_IW*20151224*` to find all Sentinel-1 A scenes from 24th of December 2015 without restricting the result to a search area.

3.1 Quickstart

```
# connect to the API
from sentinelat import SentinelAPI, read_geojson, geojson_to_wkt
from datetime import date

api = SentinelAPI('user', 'password', 'https://scihub.copernicus.eu/dhus')

# download single scene by known product id
api.download(<product_id>)

# search by polygon, time, and SciHub query keywords
footprint = geojson_to_wkt(read_geojson('/path/to/map.geojson'))
products = api.query(footprint,
                    date=('20151219', date(2015, 12, 29)),
                    platformname='Sentinel-2',
                    cloudcoverpercentage=(0, 30))

# download all results from the search
api.download_all(products)

# convert to Pandas DataFrame
products_df = api.to_dataframe(products)

# GeoJSON FeatureCollection containing footprints and metadata of the scenes
api.to_geojson(products)

# GeoPandas GeoDataFrame with the metadata of the scenes and the footprints as
↳ geometries
api.to_geodataframe(products)

# Get basic information about the product: its title, file size, MD5 sum, date,
↳ footprint and
```

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```
# its download url
api.get_product_odata(<product_id>)

# Get the product's full metadata available on the server
api.get_product_odata(<product_id>, full=True)
```

Valid search query keywords can be found at the [Copernicus Open Access Hub](#) documentation.

3.2 Authentication

The Copernicus Open Access Hub and probably most Data Hubs require authentication. You can provide your credentials with `SentinelAPI(<your username>, <your password>())`. Alternatively, you can use `SentinelAPI(None, None)()` and enter your credentials in a file `.netrc` in your user home directory in the following form:

```
machine scihub.copernicus.eu
login <your username>
password <your password>
```

Either way, if you get an error 401 Unauthorized, your credentials were wrong or not yet active for the endpoint you are contacting.

3.3 Sorting & Filtering

In addition to the [search query keywords](#) `sentinelsat` allows filtering and sorting of search results before download. To simplify these operations `sentinelsat` offers the convenience functions `to_geojson()`, `to_dataframe()` and `to_geodataframe()` which return the search results as a GeoJSON object, Pandas DataFrame or a GeoPandas GeoDataFrame, respectively. `to_dataframe()` and `to_geodataframe()` require `pandas` and `geopandas` to be installed, respectively.

In this example we query Sentinel-2 scenes over a location and convert the query results to a Pandas DataFrame. The DataFrame is then sorted by cloud cover and ingestion date. We limit the query to first 5 results within our timespan and download them, starting with the least cloudy scene. Filtering can be done with all data types, as long as you pass the `id` to the download function.

```
# connect to the API
from sentinelsat import SentinelAPI, read_geojson, geojson_to_wkt
from datetime import date

api = SentinelAPI('user', 'password', 'https://scihub.copernicus.eu/dhus')

# search by polygon, time, and SciHub query keywords
footprint = geojson_to_wkt(read_geojson('map.geojson'))
products = api.query(footprint,
                    date=('20151219', date(2015, 12, 29)),
                    platformname='Sentinel-2')

# convert to Pandas DataFrame
products_df = api.to_dataframe(products)

# sort and limit to first 5 sorted products
```

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```

products_df_sorted = products_df.sort_values(['cloudcoverpercentage', 'ingestiondate
↪'], ascending=[True, True])
products_df_sorted = products_df_sorted.head(5)

# download sorted and reduced products
api.download_all(products_df_sorted.index)

```

3.4 Getting Product Metadata

SentinelSat provides two methods for retrieving product metadata from the server, one for each API offered by the Copernicus Open Access Hub:

- `query()` for **OpenSearch (Solr)**, which supports filtering products by their attributes and returns metadata for all matched products at once.
- `get_product_odata()` for **OData**, which can be queried one product at a time but provides the full metadata available for each product, as well as information about the product file such as the file size and checksum, which are not available from OpenSearch.

Both methods return a dictionary containing the metadata items. More specifically, `query()` returns a dictionary with an entry for each returned product with its ID as the key and the attributes' dictionary as the value.

All of the attributes returned by the OpenSearch API have a corresponding but differently named attribute in the OData's full metadata response. See the DataHubSystem's metadata definition files to find the exact mapping between them (OpenSearch attributes have a `<solrField>` tag added):

- Sentinel-1 attributes
- Sentinel-2 attributes
- Sentinel-3 attributes

3.4.1 OpenSearch example

```

>>> api.query(date=('NOW-8HOURS', 'NOW'), producttype='SLC')
OrderedDict([('04548172-c64a-418f-8e83-7a4d148adf1e',
              {'acquisitiontype': 'NOMINAL',
               'beginposition': datetime.datetime(2017, 4, 25, 15, 56, 12, 814000),
               'endposition': datetime.datetime(2017, 4, 25, 15, 56, 39, 758000),
               'filename': 'S1A_IW_SLC__1SDV_20170425T155612_20170425T155639_016302_
↪01AF91_46FF.SAFE',
               'footprint': 'POLYGON ((34.322010 0.401648,36.540989 0.876987,36.
↪884121 -0.747357,34.664474 -1.227940,34.322010 0.401648))',
               'format': 'SAFE',
               'gmlfootprint': '<gml:Polygon srsName="http://www.opengis.net/gml/srs/
↪epsg.xml#4326" xmlns:gml="http://www.opengis.net/gml">\n  <gml:outerBoundaryIs>\n  ↪
↪  <gml:LinearRing>\n    <gml:coordinates>0.401648,34.322010 0.876987,36.
↪540989 -0.747357,36.884121 -1.227940,34.664474 0.401648,34.322010</gml:coordinates>
↪\n    </gml:LinearRing>\n  </gml:outerBoundaryIs>\n</gml:Polygon>',
               'identifier': 'S1A_IW_SLC__1SDV_20170425T155612_20170425T155639_016302_
↪01AF91_46FF',
               'ingestiondate': datetime.datetime(2017, 4, 25, 19, 23, 45, 956000),
               'instrumentname': 'Synthetic Aperture Radar (C-band)',
               'instrumentshortname': 'SAR-C SAR',

```

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```

        'lastorbitnumber': 16302,
        'lastrelativeorbitnumber': 130,
        'link': "https://scihub.copernicus.eu/apihub/odata/v1/Products(
↪'04548172-c64a-418f-8e83-7a4d148adf1e')/$value",
        'link_alternative': "https://scihub.copernicus.eu/apihub/odata/v1/
↪Products('04548172-c64a-418f-8e83-7a4d148adf1e')/",
        'link_icon': "https://scihub.copernicus.eu/apihub/odata/v1/Products(
↪'04548172-c64a-418f-8e83-7a4d148adf1e')/Products('Quicklook')/$value",
        'missiondatatakeid': 110481,
        'orbitdirection': 'ASCENDING',
        'orbitnumber': 16302,
        'platformidentifier': '2014-016A',
        'platformname': 'Sentinel-1',
        'polarisationmode': 'VV VH',
        'productclass': 'S',
        'producttype': 'SLC',
        'relativeorbitnumber': 130,
        'sensoroperationalmode': 'IW',
        'size': '7.1 GB',
        'slicenumber': 8,
        'status': 'ARCHIVED',
        'summary': 'Date: 2017-04-25T15:56:12.814Z, Instrument: SAR-C SAR,
↪Mode: VV VH, Satellite: Sentinel-1, Size: 7.1 GB',
        'swathidentifier': 'IW1 IW2 IW3',
        'title': 'S1A_IW_SLC__1SDV_20170425T155612_20170425T155639_016302_
↪01AF91_46FF',
        'uuid': '04548172-c64a-418f-8e83-7a4d148adf1e'}),
...

```

3.4.2 OData example

Only the most basic information available from the OData API is returned by default, if `full=True` is not set. The full metadata query response is quite large and not always required, so it is not requested by default.

```

>>> api.get_product_odata('04548172-c64a-418f-8e83-7a4d148adf1e')
{'date': datetime.datetime(2017, 4, 25, 15, 56, 12, 814000),
 'footprint': 'POLYGON((34.322010 0.401648,36.540989 0.876987,36.884121 -0.747357,34.
↪664474 -1.227940,34.322010 0.401648))',
 'id': '04548172-c64a-418f-8e83-7a4d148adf1e',
 'md5': 'E5855D1C974171D33EE4BC08B9D221AE',
 'size': 4633501134,
 'title': 'S1A_IW_SLC__1SDV_20170425T155612_20170425T155639_016302_01AF91_46FF',
 'url': "https://scihub.copernicus.eu/apihub/odata/v1/Products('04548172-c64a-418f-
↪8e83-7a4d148adf1e')/$value"}

```

With `full=True` we receive the full metadata available for the product.

```

>>> api.get_product_odata('04548172-c64a-418f-8e83-7a4d148adf1e', full=True)
{'Acquisition Type': 'NOMINAL',
 'Carrier rocket': 'Soyuz',
 'Cycle number': 107,
 'Date': datetime.datetime(2017, 4, 25, 15, 56, 12, 814000),
 'Filename': 'S1A_IW_SLC__1SDV_20170425T155612_20170425T155639_016302_01AF91_46FF.SAFE
↪',
 'Footprint': '<gml:Polygon srsName="http://www.opengis.net/gml/srs/epsg.xml#4326"
↪xmlns:gml="http://www.opengis.net/gml">\n  <gml:outerBoundaryIs>\n    (continues on next page)
↪<gml:LinearRing>\n      <gml:coordinates>0.401648,34.322010 0.876987,36.540989 -
↪0.747357,36.884121 -1.227940,34.664474 0.401648,34.322010</gml:coordinates>\n
12</gml:LinearRing>\n  </gml:outerBoundaryIs>\n</gml:Polygon>',

```


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```

'Format': 'SAFE',
'Identifier': 'S1A_IW_SLC__1SDV_20170425T155612_20170425T155639_016302_01AF91_46FF',
'Ingestion Date': datetime.datetime(2017, 4, 25, 19, 23, 45, 956000),
'Instrument': 'SAR-C',
'Instrument abbreviation': 'SAR-C SAR',
'Instrument description': '<a target="_blank" href="https://sentinel.esa.int/web/
↪sentinel/missions/sentinel-1">https://sentinel.esa.int/web/sentinel/missions/
↪sentinel-1</a>',
'Instrument description text': 'The SAR Antenna Subsystem (SAS) is developed and
↪build by AstriumGmbH. It is a large foldable planar phased array antenna, which
↪is formed by a centre panel and two antenna side wings. In deployed configuration the
↪antenna has an overall aperture of 12.3 x 0.84 m.The antenna provides a fast
↪electronic scanning capability inazimuth and elevation and is based on low loss and
↪highly stablewaveguide radiators build in carbon fibre technology, which arealready
↪successfully used by the TerraSAR-X radar imaging mission.The SAR Electronic
↪Subsystem (SES) is developed and build byAstrium Ltd. It provides all radar control,
↪ IF/ RF signalgeneration and receive data handling functions for the SARInstrument.
↪The fully redundant SES is based on a channelisedarchitecture with one transmit and
↪two receive chains, providing amodular approach to the generation and reception of
↪wide-bandsignals and the handling of multi-polarisation modes. One keyfeature is
↪the implementation of the Flexible Dynamic BlockAdaptive Quantisation (FD-BAQ) data
↪compression concept, whichallows an efficient use of on-board storage resources and
↪minimisesdownlink times.',
'Instrument mode': 'IW',
'Instrument name': 'Synthetic Aperture Radar (C-band)',
'Instrument swath': 'IW1 IW2 IW3',
'JTS footprint': 'POLYGON ((34.322010 0.401648,36.540989 0.876987,36.884121 -0.
↪747357,34.664474 -1.227940,34.322010 0.401648))',
'Launch date': 'April 3rd, 2014',
'Mission data take id': 110481,
'Mission type': 'Earth observation',
'Mode': 'IW',
'NSSDC identifier': '2014-016A',
'Operator': 'European Space Agency',
'Orbit number (start)': 16302,
'Orbit number (stop)': 16302,
'Pass direction': 'ASCENDING',
'Phase identifier': 1,
'Polarisation': 'VV VH',
'Product class': 'S',
'Product class description': 'SAR Standard L1 Product',
'Product composition': 'Slice',
'Product level': 'L1',
'Product type': 'SLC',
'Relative orbit (start)': 130,
'Relative orbit (stop)': 130,
'Satellite': 'Sentinel-1',
'Satellite description': '<a target="_blank" href="https://sentinel.esa.int/web/
↪sentinel/missions/sentinel-1">https://sentinel.esa.int/web/sentinel/missions/
↪sentinel-1</a>',
'Satellite name': 'Sentinel-1',
'Satellite number': 'A',
'Sensing start': datetime.datetime(2017, 4, 25, 15, 56, 12, 814000),
'Sensing stop': datetime.datetime(2017, 4, 25, 15, 56, 39, 758000),
'Size': '7.1 GB',
'Slice number': 8,
'Start relative orbit number': 130,

```

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```
'Status': 'ARCHIVED',
'Stop relative orbit number': 130,
'Timeliness Category': 'Fast-24h',
'date': datetime.datetime(2017, 4, 25, 15, 56, 12, 814000),
'footprint': 'POLYGON((34.322010 0.401648,36.540989 0.876987,36.884121 -0.747357,34.
↪664474 -1.227940,34.322010 0.401648))',
'id': '04548172-c64a-418f-8e83-7a4d148adf1e',
'md5': 'E5855D1C974171D33EE4BC08B9D221AE',
'size': 4633501134,
'title': 'S1A_IW_SLC__1SDV_20170425T155612_20170425T155639_016302_01AF91_46FF',
'url': "https://scihub.copernicus.eu/apihub/odata/v1/Products('04548172-c64a-418f-
↪8e83-7a4d148adf1e')/$value"
```

3.5 LTA-Products

Copernicus Open Access Hub no longer stores all products online for immediate retrieval. Offline products can be requested from the [Long Term Archive \(LTA\)](#) and should become available within 24 hours. Copernicus Open Access Hub's quota currently permits users to request an offline product every 30 minutes.

A product's availability can be checked with a regular OData query by evaluating the `Online` property value.

```
product_info = api.get_product_odata(<product_id>)

if product_info['Online']:
    print('Product {} is online. Starting download.'.format(<product_id>))
    api.download(<product_id>)
else:
    print('Product {} is not online.'.format(<product_id>))
```

When trying to download an offline product with `download()` or `download_all()`, these methods will instead attempt to trigger its retrieval from the LTA.

3.6 Logging

SentinelSAT logs to `sentinelSAT` and the API to `sentinelSAT.SentinelAPI`.

There is no predefined logging handler, so in order to have your script print the log messages, either use `logging.basicConfig`

```
import logging

logging.basicConfig(format='%(message)s', level='INFO')
```

or add a custom handler for `sentinelSAT` (as implemented in `cli.py`)

```
import logging

logger = logging.getLogger('sentinelSAT')
logger.setLevel('INFO')

h = logging.StreamHandler()
h.setLevel('INFO')
```

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```

fmt = logging.Formatter('%(message)s')
h.setFormatter(fmt)
logger.addHandler(h)

```

3.7 More Examples

3.7.1 Search Sentinel 2 by tile

To search for recent Sentinel 2 imagery by MGRS tile, use the *tileid* parameter:

```

from collections import OrderedDict
from sentinelSAT import SentinelAPI

api = SentinelAPI('user', 'password')

tiles = ['33VUC', '33UUB']

query_kwargs = {
    'platformname': 'Sentinel-2',
    'producttype': 'S2MSI1C',
    'date': ('NOW-14DAYS', 'NOW')}

products = OrderedDict()
for tile in tiles:
    kw = query_kwargs.copy()
    kw['tileid'] = tile # products after 2017-03-31
    pp = api.query(**kw)
    products.update(pp)

api.download_all(products)

```

NB: The *tileid* parameter only works for products from April 2017 onward due to missing metadata in SciHub's DHuS catalogue. Before that, but only from December 2016 onward (i.e. for single-tile products), you can use a *filename* pattern instead:

```

kw['filename'] = '*_T{}__*'.format(tile) # products after 2016-12-01

```

3.8 API Reference

```

class sentinelSAT.SentinelAPI(user, password, api_url='https://scihub.copernicus.eu/apihub',
                              show_progressbars=True, timeout=None)

```

Class to connect to Copernicus Open Access Hub, search and download imagery.

Parameters

- **user** (*string*) – username for DataHub set to None to use ~/.netrc
- **password** (*string*) – password for DataHub set to None to use ~/.netrc
- **api_url** (*string, optional*) – URL of the DataHub defaults to 'https://scihub.copernicus.eu/apihub'

- **show_progressbars** (*bool*) – Whether progressbars should be shown or not, e.g. during download. Defaults to True.
- **timeout** (*float or tuple, optional*) – How long to wait for DataHub response (in seconds). Tuple (connect, read) allowed.

session

Session to connect to DataHub

Type requests.Session

api_url

URL to the DataHub

Type str

page_size

Number of results per query page. Current value: 100 (maximum allowed on ApiHub)

Type int

timeout

How long to wait for DataHub response (in seconds).

Type float or tuple

query (*area=None, date=None, raw=None, area_relation='Intersects', order_by=None, limit=None, offset=0, **keywords*)

Query the OpenSearch API with the coordinates of an area, a date interval and any other search keywords accepted by the API.

Parameters

- **area** (*str, optional*) – The area of interest formatted as a Well-Known Text string.
- **date** (*tuple of (str or datetime) or str, optional*) – A time interval filter based on the Sensing Start Time of the products. Expects a tuple of (start, end), e.g. (“NOW-1DAY”, “NOW”). The timestamps can be either a Python datetime or a string in one of the following formats:
 - yyyyMMdd
 - yyyy-MM-ddThh:mm:ss.SSSZ (ISO-8601)
 - yyyy-MM-ddThh:mm:ssZ
 - NOW
 - NOW-<n>DAY(S) (or HOUR(S), MONTH(S), etc.)
 - NOW+<n>DAY(S)
 - yyyy-MM-ddThh:mm:ssZ-<n>DAY(S)
 - NOW/DAY (or HOUR, MONTH etc.) - rounds the value to the given unitAlternatively, an already fully formatted string such as “[NOW-1DAY TO NOW]” can be used as well.
- **raw** (*str, optional*) – Additional query text that will be appended to the query.
- **area_relation** (*{'Intersects', 'Contains', 'IsWithin'}, optional*) – What relation to use for testing the AOI. Case insensitive.
 - Intersects: true if the AOI and the footprint intersect (default)
 - Contains: true if the AOI is inside the footprint

- `IsWithin`: true if the footprint is inside the AOI
- **order_by** (*str*, *optional*) – A comma-separated list of fields to order by (on server side). Prefix the field name by ‘+’ or ‘-’ to sort in ascending or descending order, respectively. Ascending order is used if prefix is omitted. Example: “cloudcoverpercentage, -beginposition”.
- **limit** (*int*, *optional*) – Maximum number of products returned. Defaults to no limit.
- **offset** (*int*, *optional*) – The number of results to skip. Defaults to 0.
- ****keywords** – Additional keywords can be used to specify other query parameters, e.g. `relativeorbitnumber=70`. See <https://scihub.copernicus.eu/twiki/do/view/SciHubUserGuide/3FullTextSearch> for a full list.

Range values can be passed as two-element tuples, e.g. `cloudcoverpercentage=(0, 30)`. `None` can be used in range values for one-sided ranges, e.g. `orbitnumber=(16302, None)`. Ranges with no bounds (`orbitnumber=(None, None)`) will not be included in the query.

The time interval formats accepted by the `date` parameter can also be used with any other parameters that expect time intervals (that is: ‘beginposition’, ‘endposition’, ‘date’, ‘creationdate’, and ‘ingestiondate’).

Returns Products returned by the query as a dictionary with the product ID as the key and the product’s attributes (a dictionary) as the value.

Return type dict[string, dict]

static format_query (*area=None*, *date=None*, *raw=None*, *area_relation='Intersects'*, ***keywords*)
Create a OpenSearch API query string.

query_raw (*query*, *order_by=None*, *limit=None*, *offset=0*)

Do a full-text query on the OpenSearch API using the format specified in <https://scihub.copernicus.eu/twiki/do/view/SciHubUserGuide/3FullTextSearch>

DEPRECATED: use `query(raw=...)` instead. This method will be removed in the next major release.

Parameters

- **query** (*str*) – The query string.
- **order_by** (*str*, *optional*) – A comma-separated list of fields to order by (on server side). Prefix the field name by ‘+’ or ‘-’ to sort in ascending or descending order, respectively. Ascending order is used, if prefix is omitted. Example: “cloudcoverpercentage, -beginposition”.
- **limit** (*int*, *optional*) – Maximum number of products returned. Defaults to no limit.
- **offset** (*int*, *optional*) – The number of results to skip. Defaults to 0.

Returns Products returned by the query as a dictionary with the product ID as the key and the product’s attributes (a dictionary) as the value.

Return type dict[string, dict]

count (*area=None*, *date=None*, *raw=None*, *area_relation='Intersects'*, ***keywords*)

Get the number of products matching a query.

Accepted parameters are identical to `SentinelAPI.query()`.

This is a significantly more efficient alternative to doing `len(api.query())`, which can take minutes to run for queries matching thousands of products.

Returns The number of products matching a query.

Return type int

static to_geojson (*products*)

Return the products from a query response as a GeoJSON with the values in their appropriate Python types.

static to_dataframe (*products*)

Return the products from a query response as a Pandas DataFrame with the values in their appropriate Python types.

static to_geodataframe (*products*)

Return the products from a query response as a GeoPandas GeoDataFrame with the values in their appropriate Python types.

get_product_odata (*id*, *full=False*)

Access OData API to get info about a product.

Returns a dict containing the id, title, size, md5sum, date, footprint and download url of the product. The date field corresponds to the Start ContentDate value.

If *full* is set to True, then the full, detailed metadata of the product is returned in addition to the above.

Parameters

- **id** (*string*) – The UUID of the product to query
- **full** (*bool*) – Whether to get the full metadata for the Product. False by default.

Returns A dictionary with an item for each metadata attribute

Return type dict[str, Any]

Notes

For a full list of mappings between the OpenSearch (Solr) and OData attribute names see the following definition files: <https://github.com/SentinelDataHub/DataHubSystem/blob/master/addon/sentinel-1/src/main/resources/META-INF/sentinel-1.owl> <https://github.com/SentinelDataHub/DataHubSystem/blob/master/addon/sentinel-2/src/main/resources/META-INF/sentinel-2.owl> <https://github.com/SentinelDataHub/DataHubSystem/blob/master/addon/sentinel-3/src/main/resources/META-INF/sentinel-3.owl>

download (*id*, *directory_path='.'*, *checksum=True*)

Download a product.

Uses the filename on the server for the downloaded file, e.g. “S1A_EW_GRDH_1SDH_20141003T003840_20141003T003920_002658_002F54_4DD1.zip”.

Incomplete downloads are continued and complete files are skipped.

Parameters

- **id** (*string*) – UUID of the product, e.g. ‘a8dd0cfd-613e-45ce-868c-d79177b916ed’
- **directory_path** (*string*, *optional*) – Where the file will be downloaded
- **checksum** (*bool*, *optional*) – If True, verify the downloaded file’s integrity by checking its MD5 checksum. Throws InvalidChecksumError if the checksum does not match. Defaults to True.

Returns product_info – Dictionary containing the product’s info from get_product_info() as well as the path on disk.

Return type dict

Raises `InvalidChecksumError` – If the MD5 checksum does not match the checksum on the server.

download_all (*products*, *directory_path='.'*, *max_attempts=10*, *checksum=True*)

Download a list of products.

Takes a list of product IDs as input. This means that the return value of `query()` can be passed directly to this method.

File names on the server are used for the downloaded files, e.g. “S1A_EW_GRDH_1SDH_20141003T003840_20141003T003920_002658_002F54_4DD1.zip”.

In case of interruptions or other exceptions, downloading will restart from where it left off. Downloading is attempted at most `max_attempts` times to avoid getting stuck with unrecoverable errors.

Parameters

- **products** (*list*) – List of product IDs
- **directory_path** (*string*) – Directory where the downloaded files will be downloaded
- **max_attempts** (*int, optional*) – Number of allowed retries before giving up downloading a product. Defaults to 10.
- **checksum** (*bool, optional*) – If True, verify the downloaded files’ integrity by checking its MD5 checksum. Throws `InvalidChecksumError` if the checksum does not match. Defaults to True.

Raises Raises the most recent downloading exception if all downloads failed.

Returns

- *dict*[*string*, *dict*] – A dictionary containing the return value from `download()` for each successfully downloaded product.
- *dict*[*string*, *dict*] – A dictionary containing the product information for products whose retrieval from the long term archive was successfully triggered.
- *set*[*string*] – The list of products that failed to download.

static get_products_size (*products*)

Return the total file size in GB of all products in the OpenSearch response.

static check_query_length (*query*)

Determine whether a query to the OpenSearch API is too long.

The length of a query string is limited to approximately 3938 characters but any special characters (that is, not alphanumeric or `-_.*`) will take up more space.

Parameters **query** (*str*) – The query string

Returns Ratio of the query length to the maximum length

Return type float

check_files (*paths=None*, *ids=None*, *directory=None*, *delete=False*)

Verify the integrity of product files on disk.

Integrity is checked by comparing the size and checksum of the file with the respective values on the server.

The input can be a list of products to check or a list of IDs and a directory.

In cases where multiple products with different IDs exist on the server for given product name, the file is considered to be correct if any of them matches the file size and checksum. A warning is logged in such situations.

The corrupt products' OData info is included in the return value to make it easier to re-download the products, if necessary.

Parameters

- **paths** (*list[string]*) – List of product file paths.
- **ids** (*list[string]*) – List of product IDs.
- **directory** (*string*) – Directory where the files are located, if checking based on product IDs.
- **delete** (*bool*) – Whether to delete corrupt products. Defaults to False.

Returns A dictionary listing the invalid or missing files. The dictionary maps the corrupt file paths to a list of OData dictionaries of matching products on the server (as returned by `SentinelAPI.get_product_odata()`).

Return type dict[str, list[dict]]

`sentinelSAT.read_geojson(geojson_file)`
Read a GeoJSON file into a GeoJSON object.

`sentinelSAT.geojson_to_wkt(geojson_obj, feature_number=0, decimals=4)`
Convert a GeoJSON object to Well-Known Text. Intended for use with OpenSearch queries.

In case of FeatureCollection, only one of the features is used (the first by default). 3D points are converted to 2D.

Parameters

- **geojson_obj** (*dict*) – a GeoJSON object
- **feature_number** (*int, optional*) – Feature to extract polygon from (in case of MultiPolygon FeatureCollection), defaults to first Feature
- **decimals** (*int, optional*) – Number of decimal figures after point to round coordinate to. Defaults to 4 (about 10 meters).

Returns string of comma separated coordinate tuples (lon, lat) to be used by SentinelAPI

Return type polygon coordinates

3.8.1 Exceptions

exception `sentinelSAT.SentinelAPIError` (*msg=None, response=None*)
Invalid responses from DataHub.

msg
The error message.

Type str

response
The response from the server as a `requests.Response` object.

Type requests.Response

exception `sentinelSAT.InvalidChecksumError`
MD5 checksum of a local file does not match the one from the server.

I keep getting *HTTP 401 Unauthorized* messages*

This means that the given username/password combination is incorrect. Note that if you created your account recently it could take a while (a few days?) until you can use that account on *apihub* and therefore *sentinelSAT* too. You can go [here](#) to test access on the *apihub* endpoint.

The query fails with *HTTP 500 connection timed out*

SciHub servers are known to have outages due to high demand, try again later.

Query fails with ‘Longitude/Latitude is out of bounds, check your JSON format or data.’

Standard GeoJSON specification contains only WGS84 format, check if your data complies with it.

My search returns 0 results

Maybe there are no images for the specified time period, by default *sentinelSAT* will query the last 24 hours only.

Anything else?

Make sure to check the [issues](#) on [GitHub](#) too.

All notable changes to `sentinel-sat` will be listed here.

5.1 [0.13] – 2019-04-05

5.1.1 Added

- Query keywords with interval ranges now also support single-sided ranges by using `None` or `'*'` to denote no bound, for example `query(date=(None, 'NOW-1YEAR'))`. If both bounds are set to unlimited, the keyword will be removed from the query. (#210)
- Raise an exception in case of duplicate keywords present in a query. Case is ignored to match the server-side behavior. (#210)
- Support for Python 3.7
- Support for GeoJSON files with a single `Feature` without a `FeatureCollection`. (#224 @scottstanie)
- Added support for Unicode symbols in search queries. (#230)
- Raise `ValueError` exception if longitude is outside `[-180, 180]` or latitude is outside `[-90, 90]` (#236, #218 @Andrey-Raspopov)
- optional `timeout` attribute to avoid indefinite wait on response from the server (#256, @viktorbahr)
- Parsing the `Online`, `CreationDate` and `IngestionDate` fields of an OData response
- Trying to download an offline product from the Copernicus Open Access Hub triggers its retrieval from the long term archive. Downloading of the product is **not** scheduled.
- Added support for downloading Sentinel 5P data in the CLI via the `'-sentinel 5'` flag

5.1.2 Changed

- Add support in the CLI for reading credentials from `~/.netrc` and document existing functionality in the API (#90)

5.1.3 Fixed

- Spaces in query parameter values are now handled correctly by escaping them with a backslash, where appropriate. (#169, #211)
- Fixed some CLI errors not returning a non-zero exit code. (#209)
- Fixed typo for `area_relation` query parameter documentation from `'Intersection'` to `'Intersects'`. (#225 @scottstanie)
- Updated `check_query_length()` logic to match the changed server-side behavior. (#230)
- Clarify usage of GeoJSON files with CLI in docs (#229 @psal93)
- `to_geopandas()` now returns an empty `GeoDataFrame` for an empty product list input.

5.1.4 Development Changes

- Replaced `[test]` and `[docs]` with a single `[dev]` installation extras target. (#208)
- Adapted `.travis.yml` to build `fiona` and `pyproj` from source for Python 3.7.
- Minimum `pytest` version `pytest >= 3.6.3` required by `pytest-socket`.
- The existing practice of not accessing the network from unit tests, unless running with `--vcr record_new` or `--vcr reset`, is now enforced by throwing a `SocketBlockedError` in such cases. (#207)

5.2 [0.12.2] – 2018-06-20

5.2.1 Added

- made exceptions more verbose regarding optional dependencies (#176)
- CLI `username`, `password` and `DHuS URL` can be set with environment variables `DHUS_USER`, `DHUS_PASSWORD` and `DHUS_URL` (#184, @temal-)
- added information about known errors and `DHuS` issues to docs (#186, @martinber)

5.2.2 Changed

- remove hard coded product type list from cli (#190, @lenniezelk)
- Made the function signature of `count()` fully compatible with `query()`. Irrelevant parameters are simply ignored.

5.2.3 Deprecated

- environment variables `SENTINEL_USER` and `SENTINEL_PASSWORD` are superceded by `DHUS_USER` and `DHUS_PASSWORD`

5.2.4 Fixed

- Updated handling of invalid queries. An exception is raised in such cases. #168
- Fixed `order_by` parameter being ignored in queries that require multiple subqueries (that is, queries that return more than 100 products) (#200)
- Special handling of quote symbols in query strings due to a server-side error is no longer necessary and has been removed. #168
- Updated effective query length calculation in `check_query_length()` to reflect server-side changes.
- skip failing tests on optional dependency Pandas for Python 3.3 and 3.4
- Unit tests work irrespective of the directory they are run from.

5.3 [0.12.1] – 2017-10-24

5.3.1 Changed

- Made checksumming the default behavior, and removed its flag from the CLI. (@gbaier2)

5.3.2 Fixed

- set `requests` encoding to UTF8
- fixed a backwards incompatible change in the `geojson` dependency
- inconsistent documentation on the use of range parameters such as `date=`

5.4 [0.12.0] – 2017-08-10

5.4.1 Added

- Option to change the type of spatial relation for the AOI in `query()`. The choices are 'Intersects', 'Contains' and 'IsWithin'.
- `order_by` option to `query()` which controls the fields by which the products are sorted on the server side before being returned. `-o/--order-by` on the CLI.
- `limit` the number of products returned by `query()` and to set the number of products to skip via `offset`. `-l/--limit` on the CLI.
- Added `raw` parameter to `query()` to append any additional raw query string to the query.
- Query parameters that take intervals as values can now be passed a tuple of the interval range values.
- Date validation and parsing has been extended to all date-type parameters in queries, such as 'ingestiondate'.
- Added `count()` which quickly returns the number of products matching a query on the server without retrieving the full response.
- Method `check_query_length` to check if a query will fail because of being excessively long.
- Option to adjust the number of decimal figures in the coordinates of the WKT string returned by `geojson_to_wkt()`.

- CLI option to query by UUID (`--uuid`) or filename (`--name`).
- A more informative error message is shown if a too long query string was likely the cause of the query failing on the server side. This can be useful if the WKT string length would cause the query to fail otherwise.
- Progressbars can be disabled by setting `show_progressbars` to `False`. Progressbars may be customized by overriding the `_tqdm()` method.
- Contribution guidelines.
- Tests for validity of documentation and RST files.

5.4.2 Changed

- Merged CLI subcommands `sentinel search` and `sentinel download` into `sentinelSAT`.
- CLI uses keywords instead of positional arguments, i.e. `--user <username>`.
- `initial_date` and `end_date` parameters in `query()` have been replaced with a single `date` parameter that takes a tuple of start and end dates as input.
- Files being downloaded now include an `.incomplete` suffix in their name until the download is finished.
- Removed `check_existing` option from `download()` and `download_all()`. Similar functionality has been provided in the new `check_files()` function.
- `format_query_date` has been changed into a public function.
- Added a progressbar to long-running queries.
- Tests can now be run from any directory rather than the repository root.
- Made the query string slightly more compact by getting rid of unnecessary ‘AND’ operators, spaces and parentheses.
- Reduced the size of the VCR.py cassettes used in unit tests.
- changed license from AGPLv3 to GPLv3+

5.4.3 Deprecated

- `query_raw()` has been merged with `query()` and is deprecated. Use `query(raw=...)` instead.

5.4.4 Fixed

- Show the correct progress value in the download progressbar when continuing from an incomplete file. (Thanks @gbaier!)
- Added a workaround for a server-side bug when plus symbols are used in a query.

5.5 [0.11] – 2017-06-01

5.5.1 Changed

- Replace `pycurl` dependency with `requests`. This makes installation significantly easier. (#117)
- An exception is raised in `download_all()` if all downloads failed.

- Change ‘SentinelSAT Scientific Datahub’ to ‘Copernicus Open Access Hub’ (#100)
- Renamed `py.test` option `--vcr reset_all` to `--vcr reset` to better reflect its true behavior.

5.6 [0.10] – 2017-05-30

5.6.1 Added

- GeoJSON footprints are allowed to contain just a single geometry instead of a feature collection. Any geometry type that has a WKT equivalent is supported (rather than only Polygons).
- `get_product_odata()` can be used to get the full metadata information available for a product if `full=True` is set.
- Added `query_raw()` that takes full text search string as input and returns a parsed dictionary just like the updated `query()` method.
- CLI: `--sentinel=<int>` option to select satellite (constellation)

5.6.2 Changed

- `SentinelAPI`, etc. can be directly imported from `sentinelSAT` rather than `sentinelSAT.sentinel`.
- `query()` changes:
 - The `area` argument expects a WKT string as input instead of a coordinate string. (Issue #101)
 - Date arguments can be disabled by setting them to `None` and their values are validated on the client side. (Issue #101)
 - The return value has been changed to a dict of dicts of parsed metadata values. One entry per product with the product ID as the key.
- `download_all()` expects a list of product IDs as input. This is compatible with the output of `query()`.
- `get_coordinates()` has been replaced with functions `read_geojson()` and `geojson_to_wkt()`. (Issue #101)
- Use more compact and descriptive error messages from the response headers, if available.

5.6.3 Deprecated

- CLI: `--sentinel1` and `--sentinel2` will be removed with the next major release

5.6.4 Removed

- `to_dict()` has been removed since it is no longer required.
- `load_query()` has been made private (renamed to `_load_query()`).

5.6.5 Fixed

- Fixed invalid GeoJSON output in both the CLI and API. (Issue #104)
- Fixed broken reporting of failed downloads in the CLI. (Issue #88)
- Attempting to download a product with an invalid ID no longer creates an infinite loop and a more informative error message is displayed in the CLI.

5.7 [0.9.1] – 2017-03-06

5.7.1 Added

- `--version` option to command line utilities
- install requirements for building the documentation
- documentation of sorting with `to_*` convenience functions

5.8 [0.9] – 2017-02-26

5.8.1 Added

- Added `to_dict`, `to_dataframe` and `to_geodataframe` which convert the response content to respective types. The `pandas`, `geopandas` and `shapely` dependencies are not installed by default.

5.8.2 Changed

- `--footprints` now includes all returned product properties in the output.
- `KeyError('No results returned.')` is no longer returned for zero returned products in a response.
- Renamed `get_footprint` to `to_geojson` and `get_product_info` to `get_product_odata`.
- Added underscore to methods and functions that are not expected to be used outside the package.
- Instance variables `url` and `content` have been removed, `last_query` and `last_status_code` have been made private.

5.9 [0.8.1] – 2017-02-05

5.9.1 Added

- added a changelog

5.9.2 Changed

- use logging instead of print

5.9.3 Fixed

- docs represent new `query` and `download_all` behaviour

5.10 [0.8] – 2017-01-27

5.10.1 Added

- options to create new, reset or ignore vcr cassettes for testing

5.10.2 Changed

- `query` now returns a list of search results
- `download_all` requires the list of search results as an argument

5.10.3 Removed

- `SentinelAPI` does not save query results as class attributes

5.11 [0.7.4] – 2017-01-14

5.11.1 Added

- Travis tests for Python 3.6

5.12 [0.7.3] – 2016-12-09

5.12.1 Changed

- changed `SentinelAPI` `max_rows` attribute to `page_size` to better reflect pagination
- tests use `vcrpy` cassettes

5.12.2 Fixed

- support GeoJSON polygons with optional (third) z-coordinate

5.13 [0.7.1] – 2016-10-28

5.13.1 Added

- pagination support for query results

5.13.2 Changed

- number of query results per page set to 100

5.14 [0.6.5] – 2016-06-22

5.15 Added

- support for large queries

5.15.1 Changed

- Removed redundant information from Readme that is also present on Readthedocs

5.16 [0.6.4] – 2016-04-06-03

5.16.1 Changed

- `initial_date / --start` changed from ingestion to acquisition date

5.17 [0.6.1] – 2016-04-22

5.17.1 Added

- Sphinx documentation setup with autodoc and numpydoc
- Redthedocs.org integration

5.18 [0.5.5] – 2016-01-13

5.18.1 Added

- Sentinel-2 support

5.19 [0.5.1] – 2015-12-18

5.19.1 Added

- Travis added as continuous integration service for automated testing

5.20 [0.5] – 2015-12-09

5.20.1 Added

- validate downloaded products with their MD5 checksums

5.21 [0.4.3] – 2015-11-23

5.21.1 Added

- option to select a different dhus api `--url`

5.21.2 Changed

- `https://scihub.esa.int/apihub/` as standard url

5.22 [0.4] – 2015-09-28

5.22.1 Added

- method to manually select the CA certificate bundle
- function to return footprints of the queried Sentinel scenes

5.22.2 Fixed

- CA-certificate SSL errors

5.23 [0.3] – 2015-06-10

5.23.1 Added

- `--query` parameter to use extra search keywords in the cli

5.24 [0.1] – 2015-06-05

- first release

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