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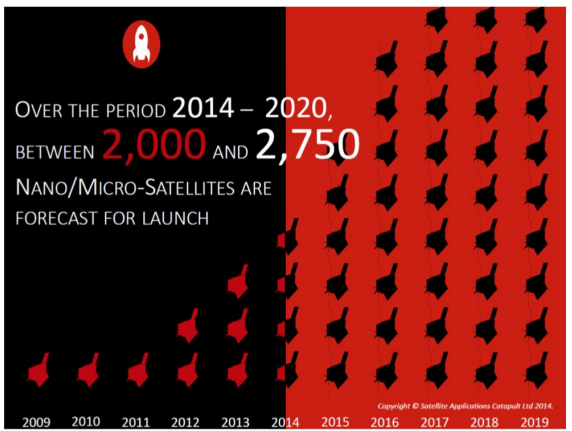
2026-05-06

Digital Earth Sweden

Sebastian Hafner, Space Technology Group, RISE Research Institutes of Sweden

New Era of Earth Observation

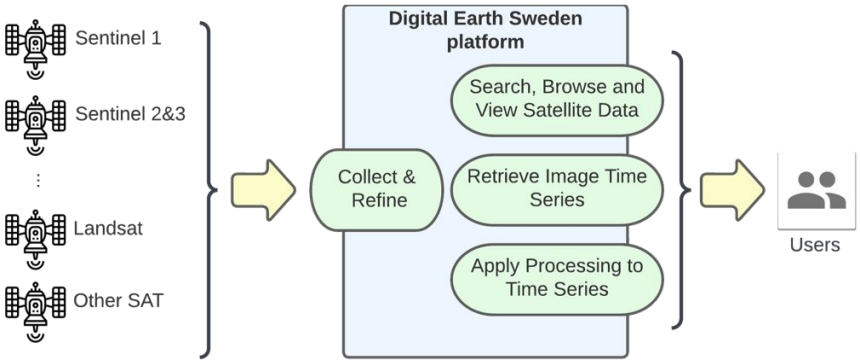
International, national space agencies and innovative companies are supporting various Earth observation programs acquiring huge volumes of data every day



Digital Earth Sweden

The Digital Earth Sweden Platform

- We want to empower Swedish authorities to seamlessly benefit from EO data analysis
- Support and enable EO-based innovation



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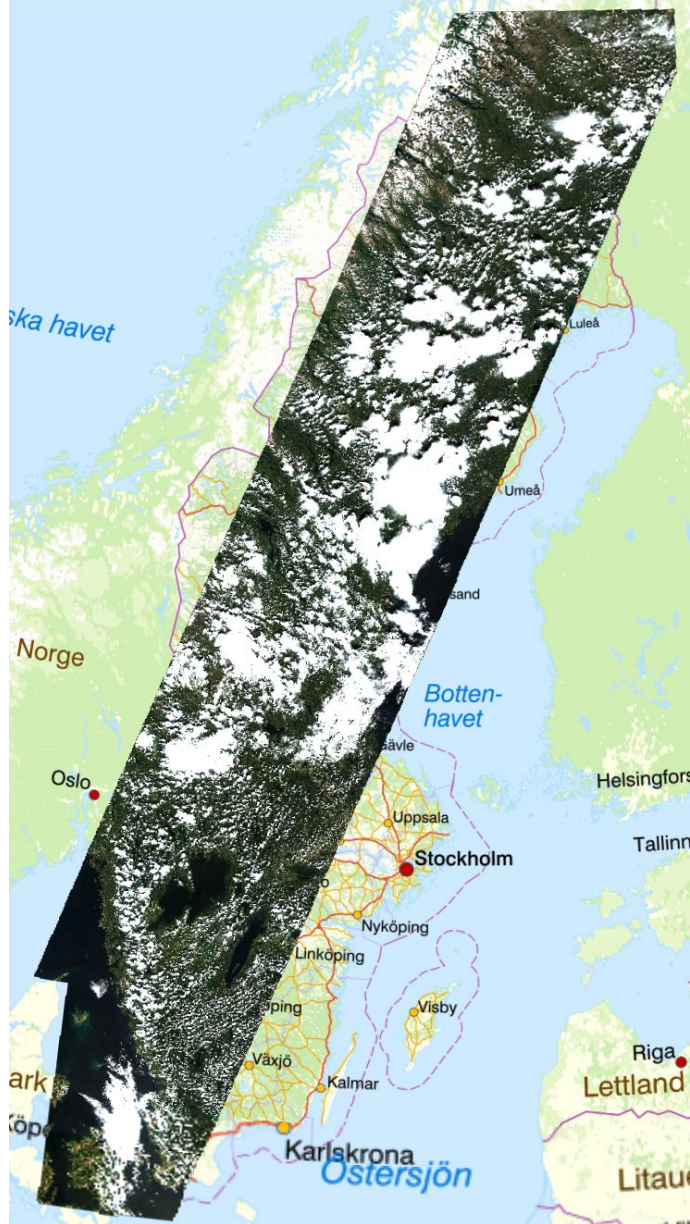
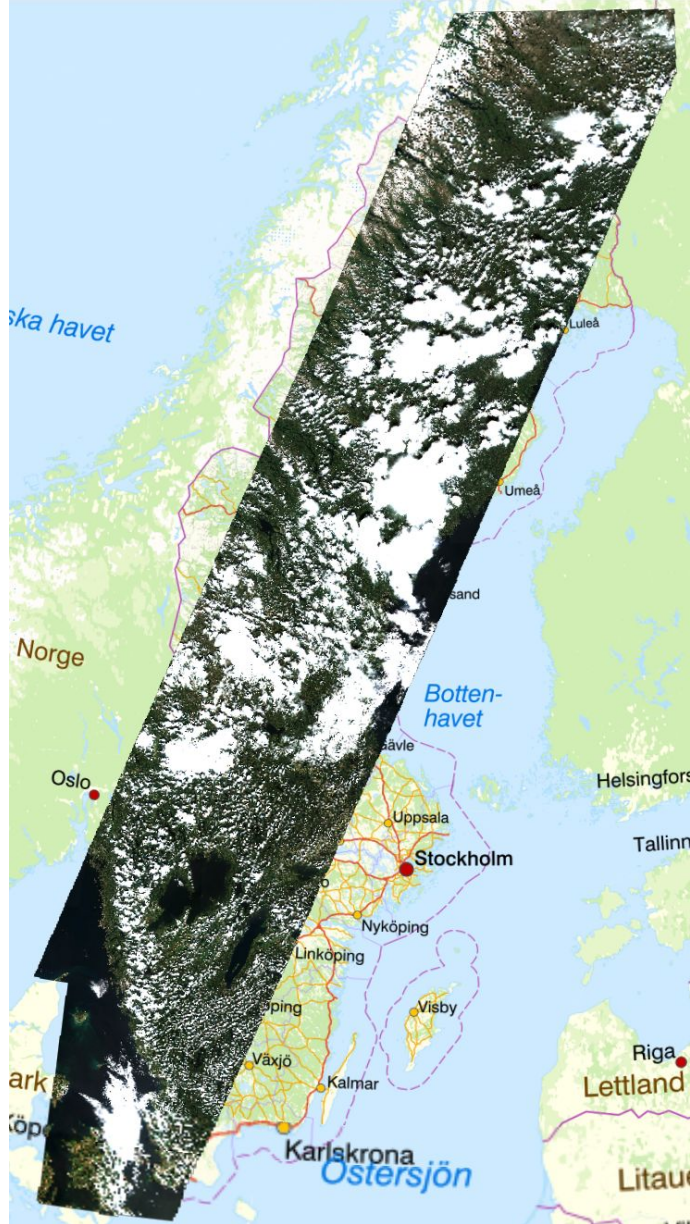


Digital Earth Sweden

The Digital Earth Sweden Platform

- Large archive of satellite data
  - Long time series of Sentinel-2 data over Sweden



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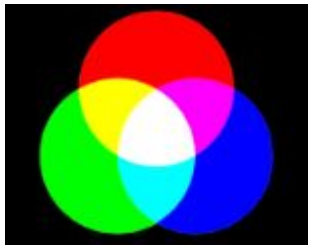
Sentinel-2 Mission

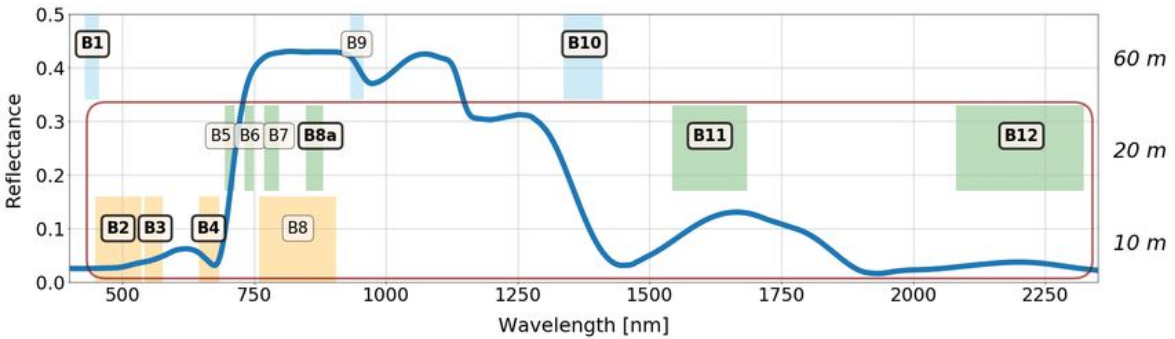
Digital Earth Sweden

- Every 5 days
- Multispectral
- 10-60 m

ESA Sentinel-2



False Color
R: NIR (B8)
G: Red (B4)
B: Green (B3)



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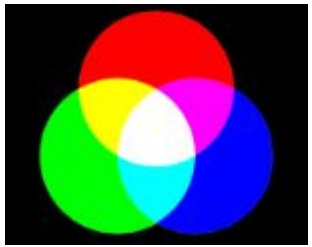
Sentinel-2 Mission

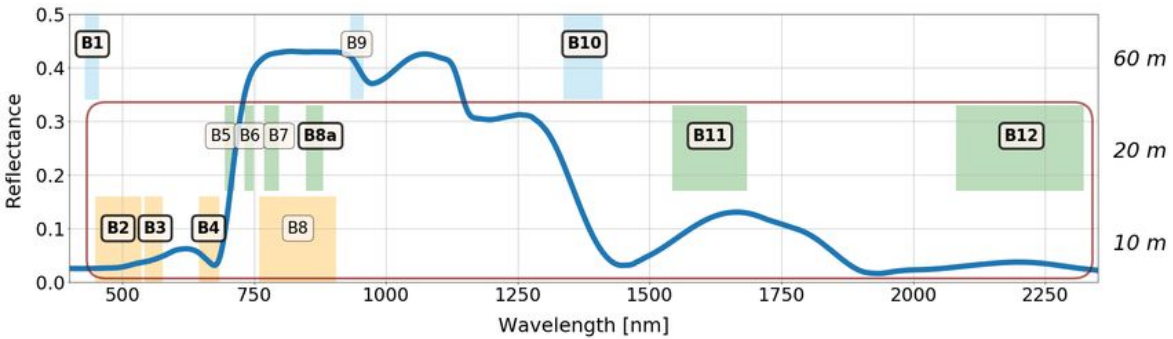
Digital Earth Sweden

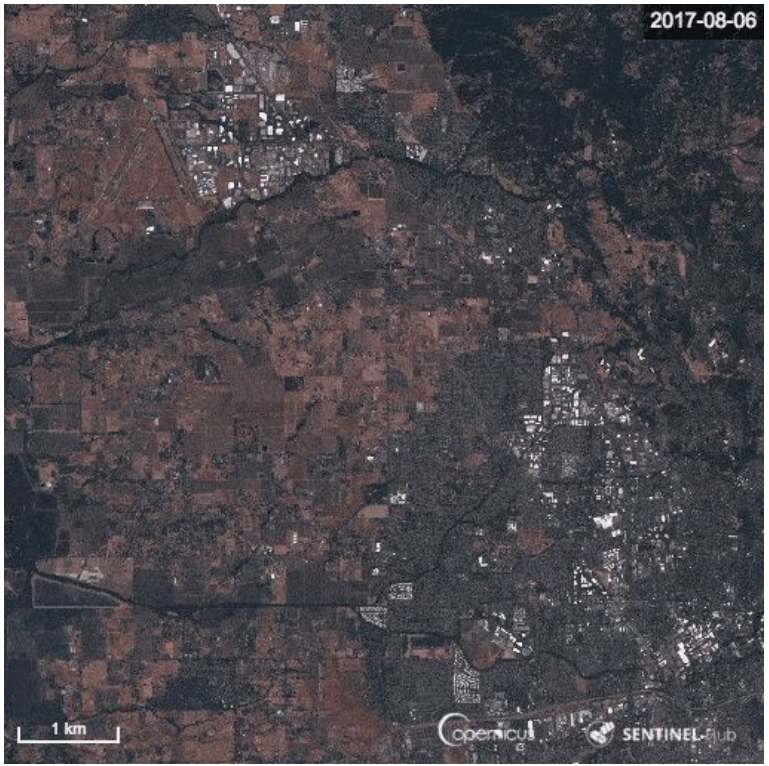
- Every 5 days
- Multispectral
- 10-60 m

ESA Sentinel-2



True Color
R: Red (B4)
G: Green (B3)
B: Blue (B2)





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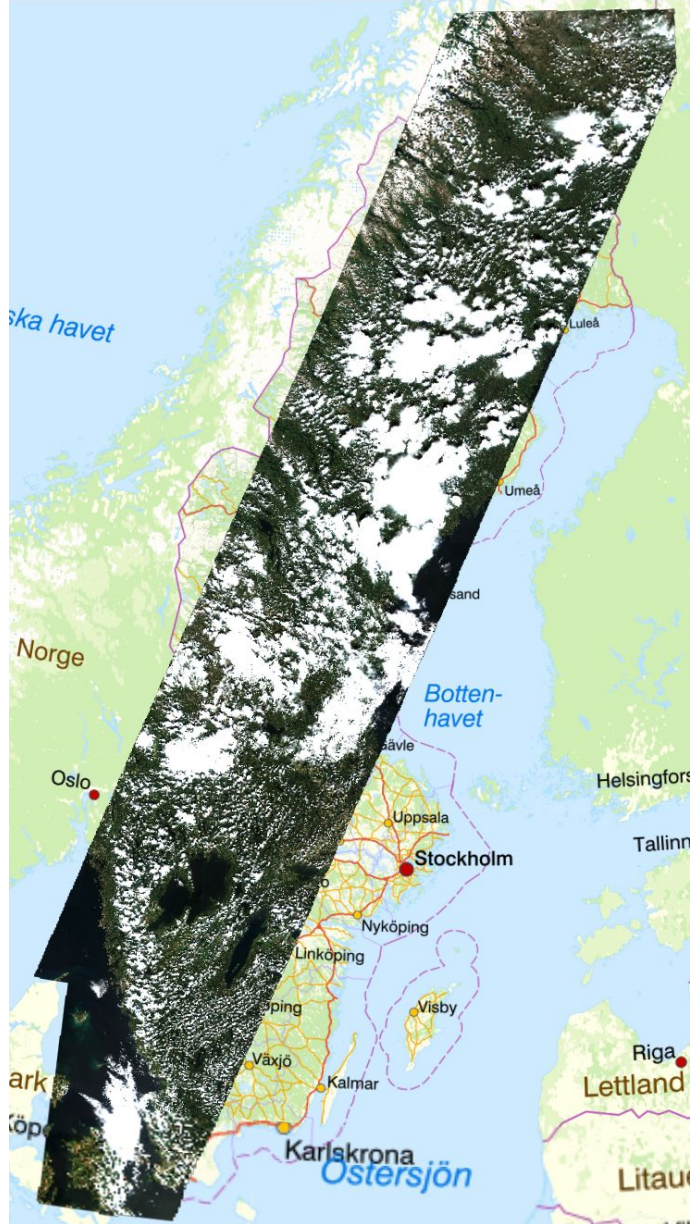
Digital Earth Sweden

The Digital Earth Sweden Platform

- Large archive of satellite data
  - Long time series of Sentinel-2 data over Sweden
  - Data is stored at RISE ICE datacentre in Luleå
- Scalable tools for analysis of satellite data
- Available for everyone to use, today!
- With Sweden and its surroundings as primary focus



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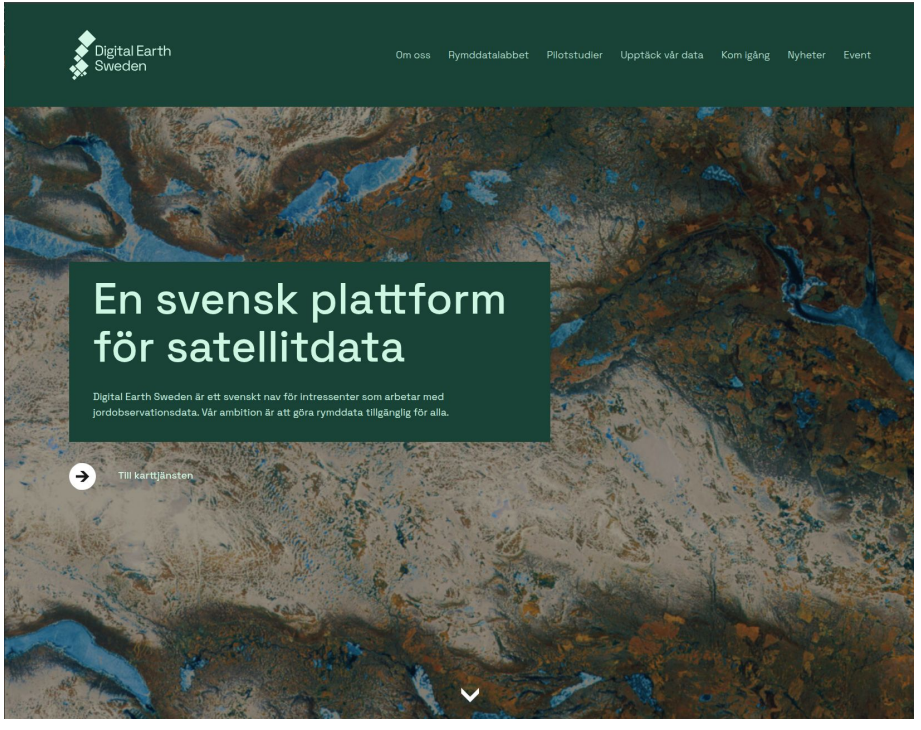
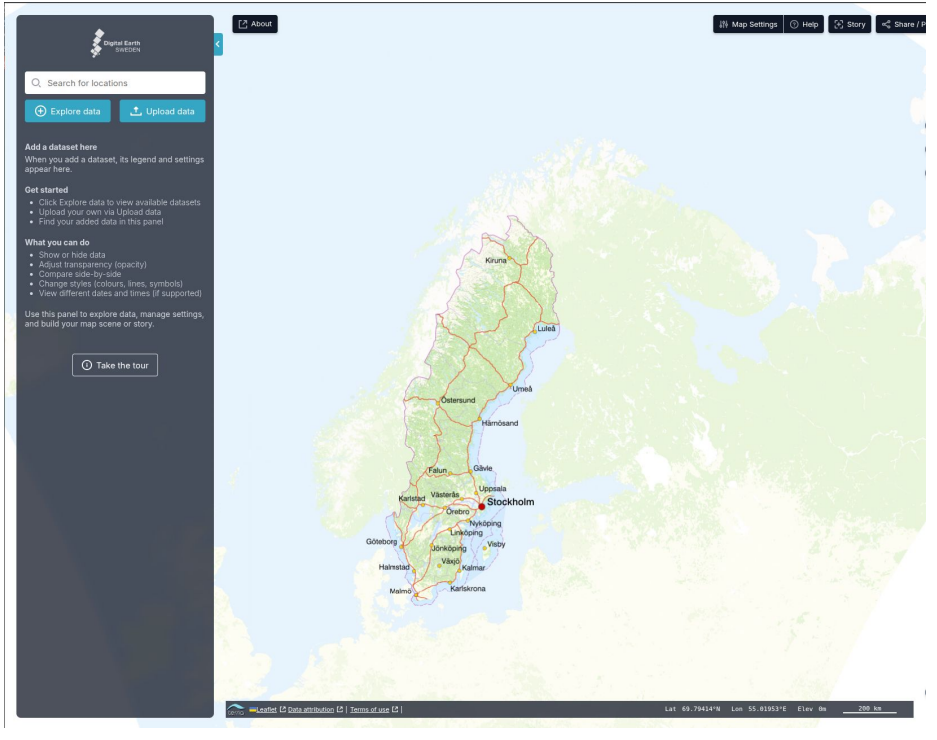
User Interface

Digital Earth Sweden





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DES User Interface

Digital Earth Sweden

- Customize basemap
- Explore data
  - Various datasets
  - DES satellite data
- Filter Sentinel-2 data by region
- Select scene
- Select visualization incl. spectral indices (e.g., NDVI)

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DES Programming Interface

Digital Earth Sweden

- Our API lets you load satellite image collections, perform processing tasks, and download results using Python
- openEO API to give you full control of your workflows, including a variety of in-built EO functionalities
- We provide tutorials (Python) on our community repository

openEO

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DES Programming Interface

Digital Earth Sweden

Getting started

Connecting to the back-end using OpenEO

```
import openeo
connection = openeo.connect('https://openeo.digitalearth.se')
connection.authenticate_basic(username='testuser', password='secretpassword')
```

```
<Connection to 'https://openeo.digitalearth.se/' with BasicBearerAuth>
```

Collections

In OpenEO, we begin by loading **collections** (datasets containing satellite imagery and other geospatial data) into a datacube. A collection is essentially a large repository of data.

```
# Listing available collections on Digital Earth Sweden
connection.list_collection_ids()
```

```
['NMD_2018_Basskikt_v1_1',
 'NMD_2018_Produktivitet_v1_1',
 's2_msi_l1c',
 's2_msi_l2a']
```

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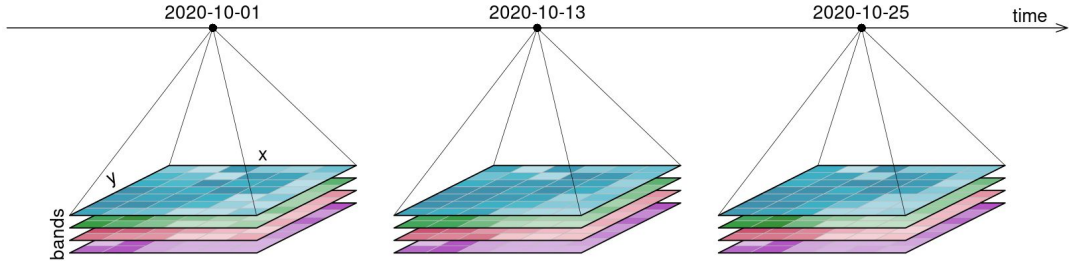
DES Programming Interface

Loading datacubes

```
aoi = {
    'west': 13.460930954751282,
    'east': 13.585449709728213,
    'south': 59.36327761288911,
    'north': 59.40107161575003,
    'crs': 'EPSG:4326',
}
timespan = ['2021-11-12', '2021-11-13']

datacube = connection.load_collection(
    collection_id = 's2_msi_l2a',
    spatial_extent = aoi,
    temporal_extent = timespan,
    bands = ['b02', 'b03', 'b04', 'b08'],
)
```



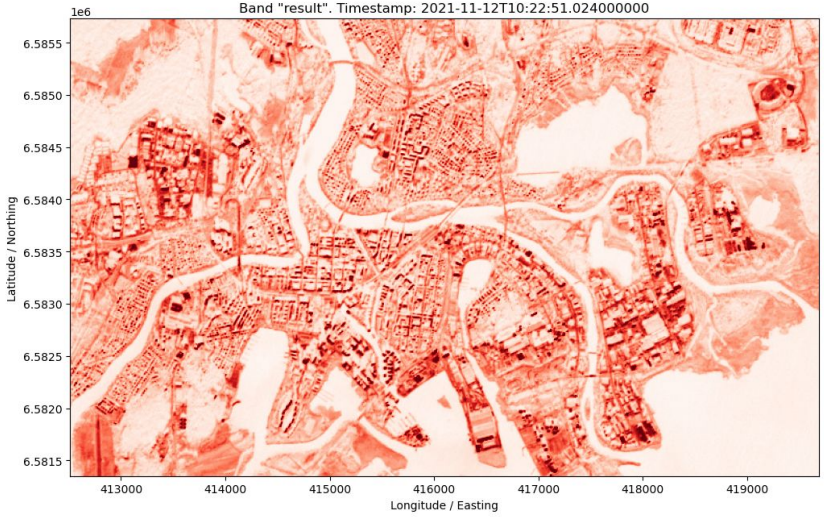
DES Programming Interface

Downloading data

```
connection.list_file_formats # Browsable description
connection.list_output_formats() # Textual representation
```

```
{'GTiff': {'title': 'GeoTiff', 'gis_data_types': ['raster'], 'parameters': {}},
 'netCDF': {'title': 'netCDF', 'gis_data_types': ['raster'], 'parameters': {}},
 'JSON': {'title': 'json', 'gis_data_types': ['vector'], 'parameters': {}}}
```

```
## Downloading the red band of our datacube
red_tif = datacube.band('b04').download(format='GTiff')
```

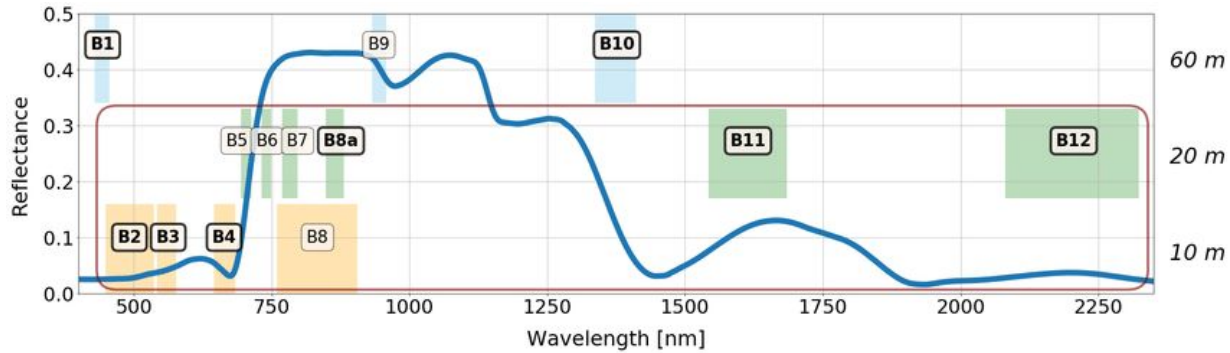


DES Programming Interface

Spectral indices via band math

- Combine spectral bands (per-pixel rations) to highlight specific features
- Normalized Difference Vegetation Index (NDVI):

$$\mathrm{NDVI} = \frac{\mathrm{NIR} - \mathrm{Red}}{\mathrm{NIR} + \mathrm{Red}} = \frac{B08 - B04}{B08 + B04}$$



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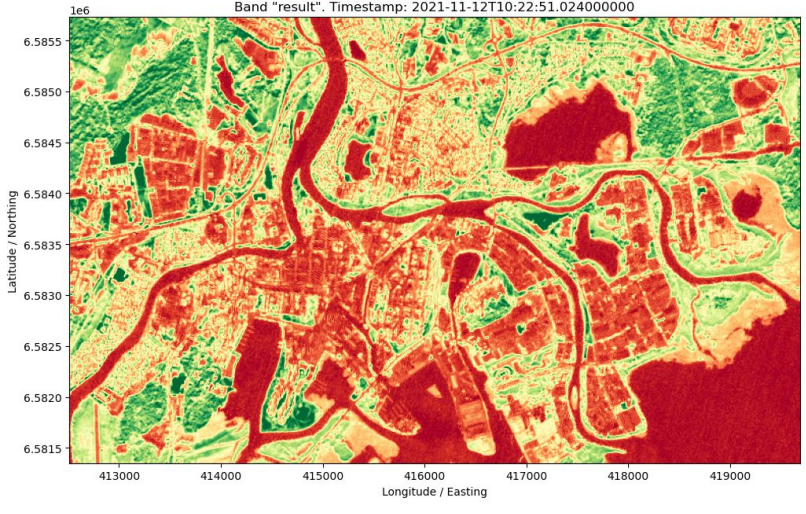
NDVI in Digital Earth Sweden

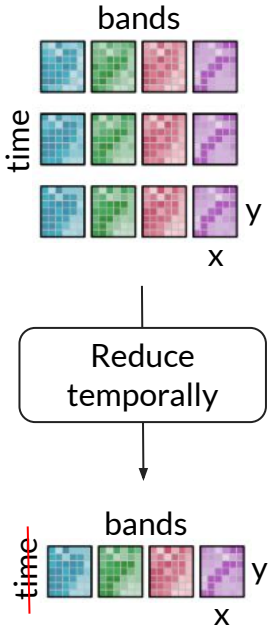
```
red = datacube.band('b04')
nir = datacube.band('b08')
ndvi_band_math = (nir - red) / (nir + red)

ndvi_band_math_tif = ndvi_band_math.download(format='GTiff')
show_single_result(ndvi_band_math_tif, is_ndvi=True)
```

```
ndvi_builtin = datacube.ndvi(nir='b08', red='b04')
ndvi_builtin_tif = ndvi_builtin.download(format='GTiff')
show_single_result(ndvi_builtin_tif, is_ndvi=True)
```



DES Programming Interface

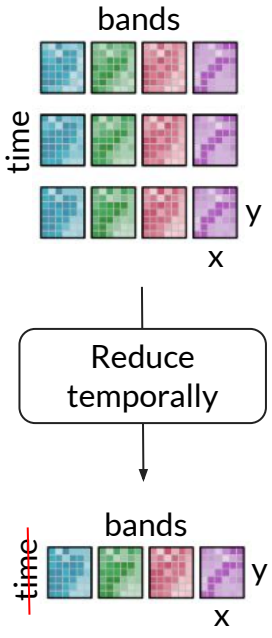
Compositing via temporal reduction

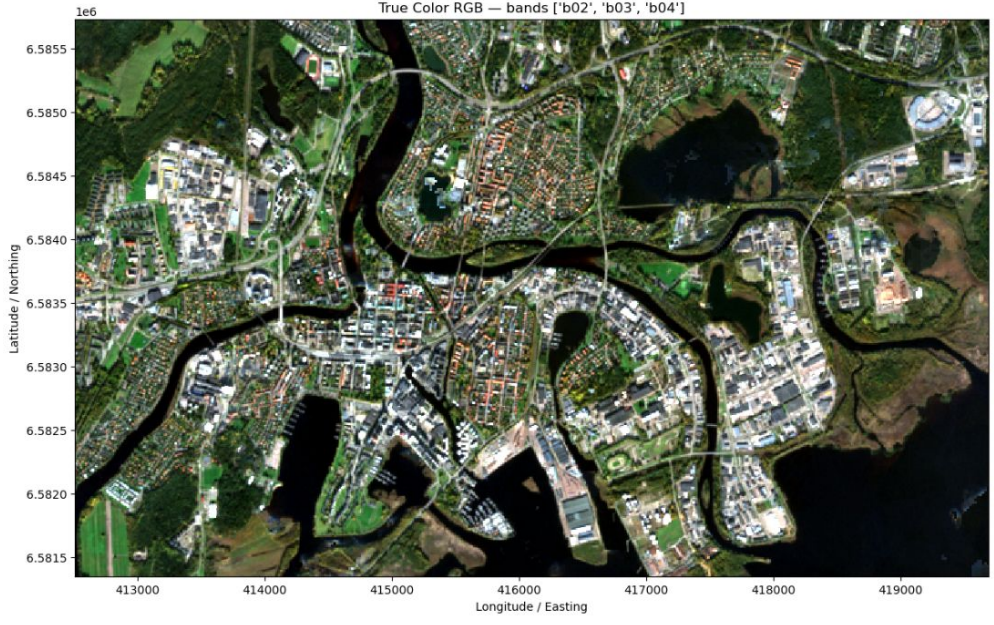



```python
# Loading all Sentinel-2 scenes acquired over Karlstad in October 2025
timespan = ['2025-10-01', '2025-11-01']
cloud_cover_threshold = 80  # Exclude scenes with more than 80% cloud cover

datacube = connection.load_collection(
    collection_id = 's2_msi_l2a',
    spatial_extent = aoi,
    temporal_extent = timespan,
    bands = ['b02', 'b03', 'b04'],
    properties={"eo:cloud_cover": lambda cc: cc < cloud_cover_threshold},
)

# Harmonization and scaling of Sentinel-2 data: # https://clearsky.vision/knowledge/sentinel2-scaling-harmonization
datacube = datacube.subtract(1_000)
# datacube = datacube.divide(10_000)  # scale to 0.0–1.0 reflectance (optional)

# Reduce the time (t) dimension of the data cube by taking the per-pixel median.
# The result is a single 3-D image: (band, y, x)
median_image = datacube.reduce_dimension(dimension='t', reducer='median')
```

DES Programming Interface

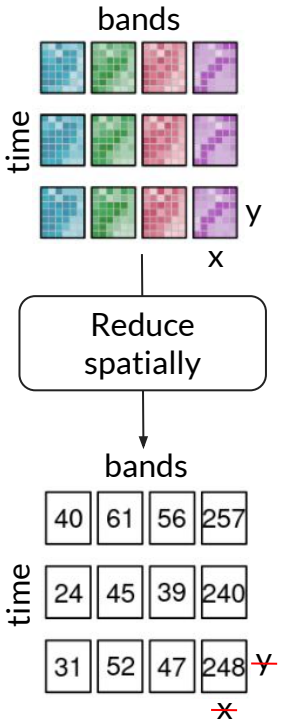
Compositing via temporal reduction

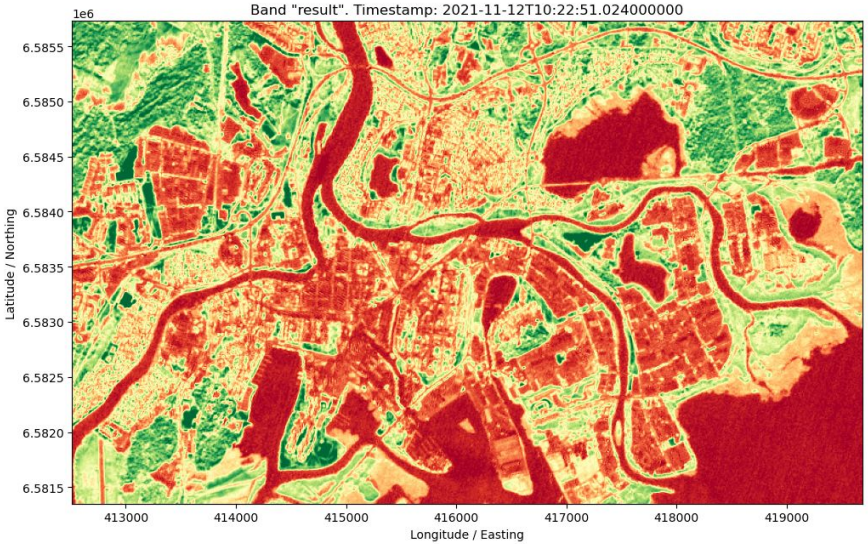




DES Programming Interface

Area statistics via spatial reduction



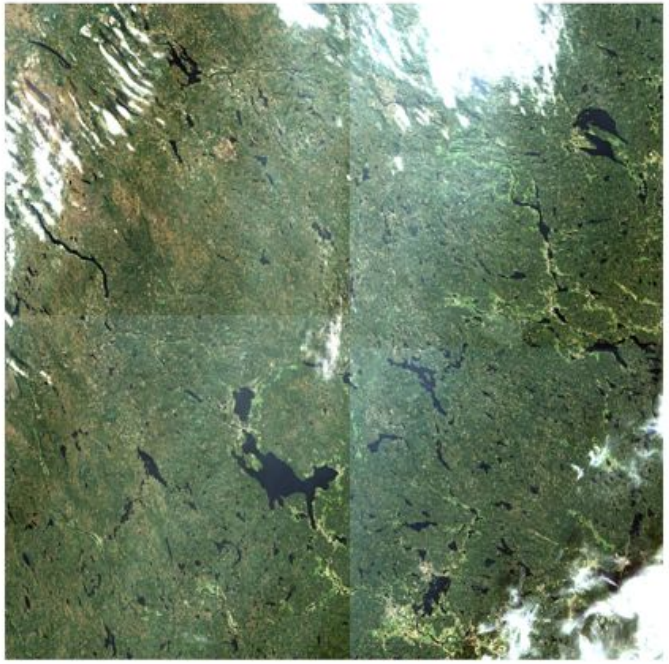


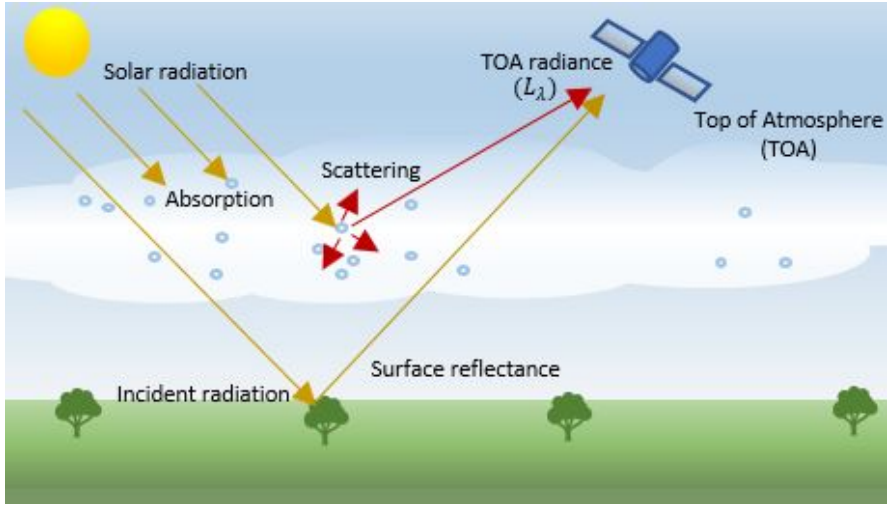
Reduce spatially → Urban green statistics

Coming to DES in May 2026

Digital Earth Sweden

Limitations of Sentinel-2 L2A data provided by ESA





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Coming to DES in May 2026

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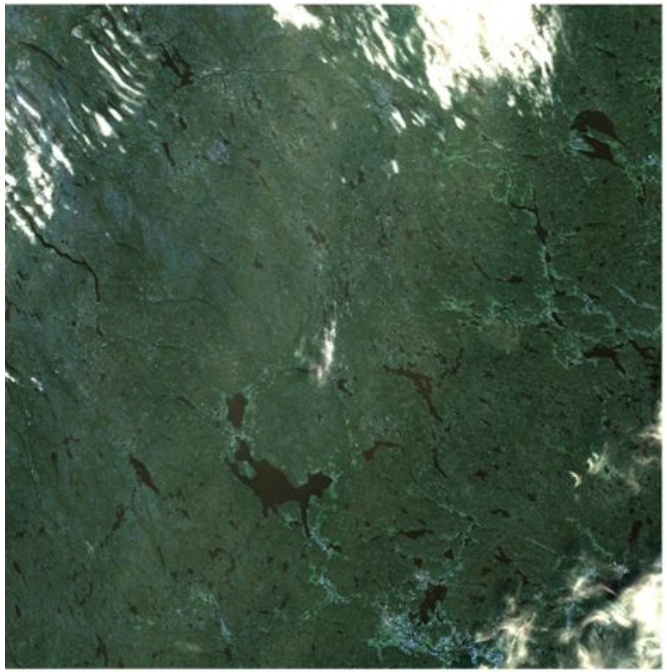
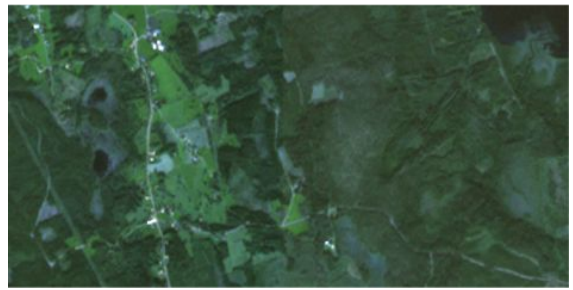
Improved L2A product for Sentinel-2



L2A product from Copernicus Data Space Ecosystem



L2A product produced with FORCE

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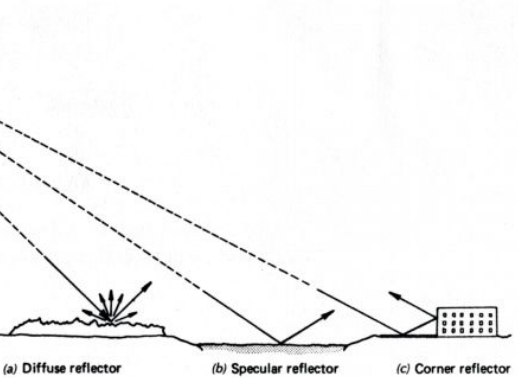
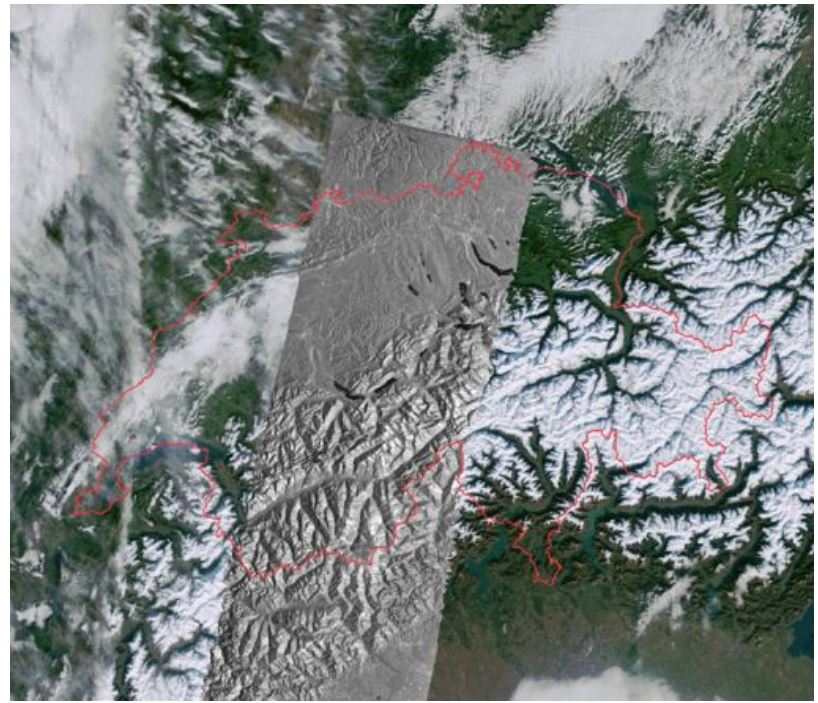
Also coming soon to DES

- Every 6 days
- SAR
- 20 m resolution

ESA
Sentinel-1





Credit: University of Zurich, RSL

SATDES Project

Co-funded by the European Union

Earth Observation Data for Urban Land Use and Agri-Environmental Statistics

Data pipeline for urban green statistics

EU funded project “Earth Observation Data for Urban Land Use and Agri-Environmental Statistics” (Project 101195601 — 2024-SE-GEOS_SATDES)

SATDES – Task 1

Co-funded by the European Union

Data pipeline for urban green statistics

- Urban green areas are increasingly under pressure
- National land cover maps must be updated more frequently to capture change
- Annual NDVI composites are generated to update the urban green class in land cover products

EU funded project “Earth Observation Data for Urban Land Use and Agri-Environmental Statistics” (Project 101195601 — 2024-SE-GEOS_SATDES)

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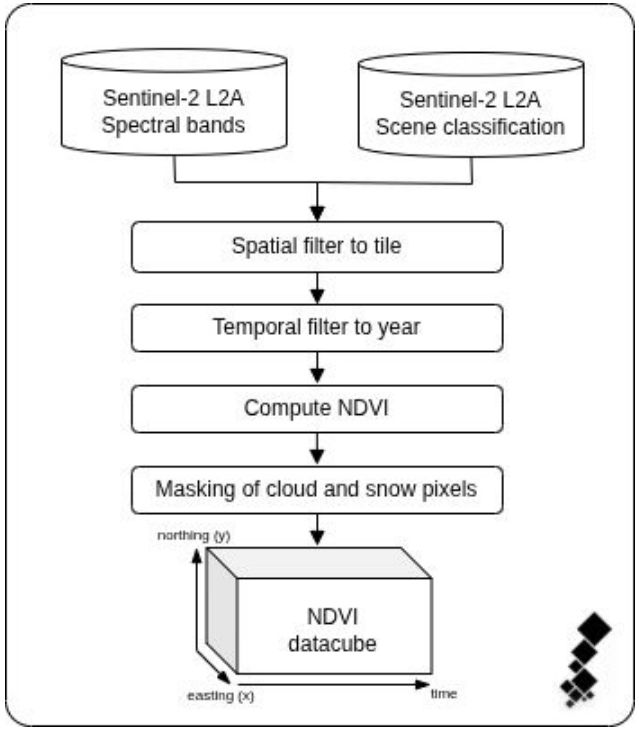
Retrieve cloud-free NDVI timeseries using DES infrastructure




```python
spectral_cube = conn.load_collection(
    "s2_msi_l2a",
    spatial_extent = spatial_extent,
    temporal_extent = temporal_extent,
    bands = ['b02', 'b03', 'b04','b08'],
    properties = {'eo:cloud_cover': lambda val: val < cloud_cover_threshold},
)
scl_cube = conn.load_collection(
    "s2_msi_l2a",
    spatial_extent = spatial_extent,
    temporal_extent = temporal_extent,
    bands = ['scl'],
    properties = {'eo:cloud_cover': lambda val: val < cloud_cover_threshold},
)

# Computing NDVI
ndvi_cube = spectral_cube.ndvi(nir="b08",red="b04")
scl_band = scl_cube.band("scl")

# Mask for clouds and snow/ice (SCL values 8, 9, 10, 11)
cloud_mask = (scl_band == 8) | (scl_band == 9) | (scl_band == 10) | (scl_band == 11)
cloud_mask = cloud_mask.resample_cube_spatial(ndvi_cube)
ndvi_masked_cube = ndvi_cube.mask(cloud_mask)
```

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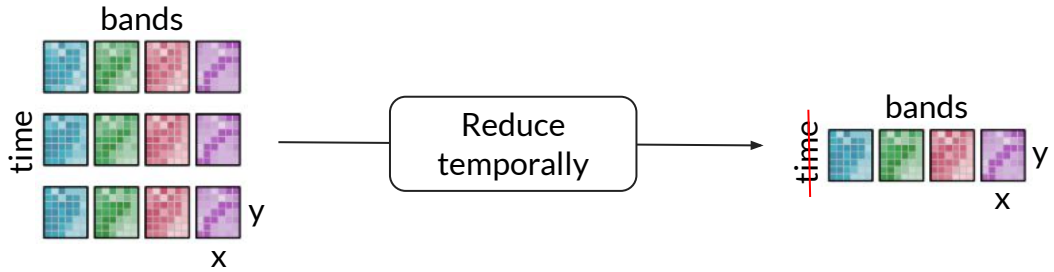
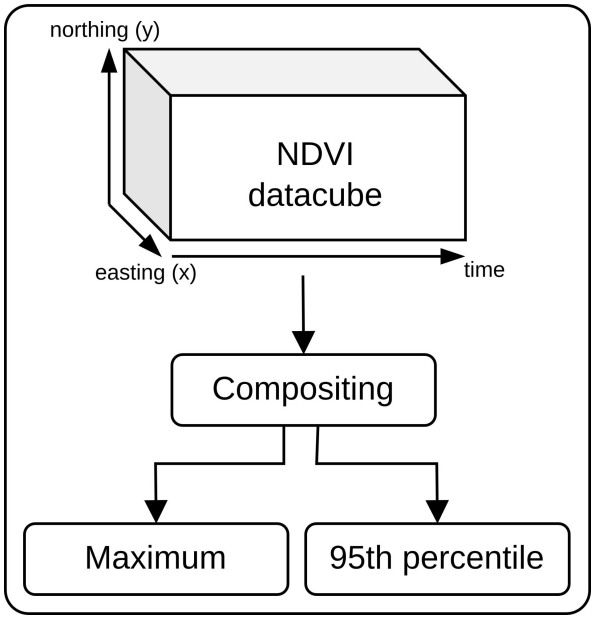
SATDES – Task 1

Compositing

- Creating a composite by reducing the temporal dimension






```
max_ndvi = datacube.reduce_dimension(dimension='t', reducer='max')
```

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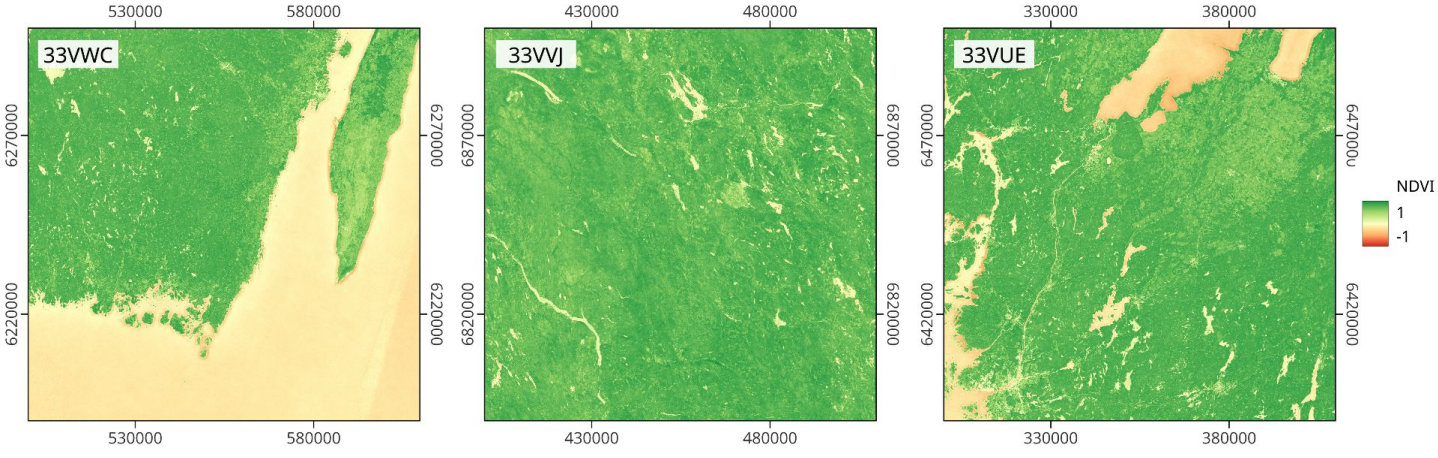
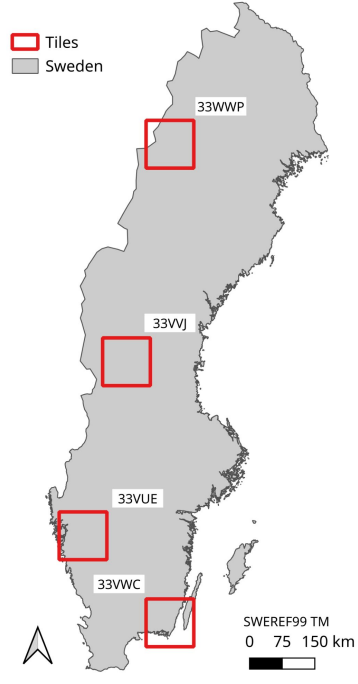
Maximum NDVI products





Summary

- Earth observation delivers consistent, large-scale imagery with frequent revisits — ideal for monitoring dynamic landscapes
- Digital Earth Sweden makes powerful Earth observation data accessible to researchers and practitioners
- Applications such as urban green mapping can be built natively within Digital Earth Sweden, from data access to analysis

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Thank you!