openEO

Jeroen Dries

Enabling Copernicus Big Data Analytics through European Open Science Cloud

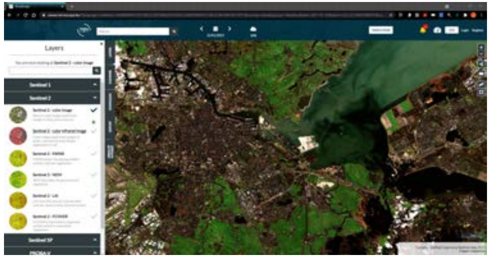
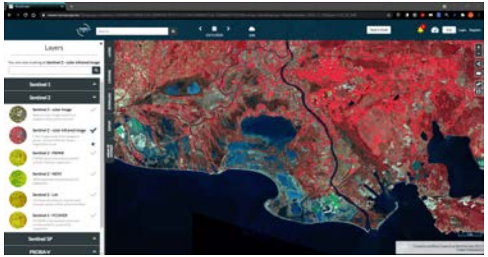
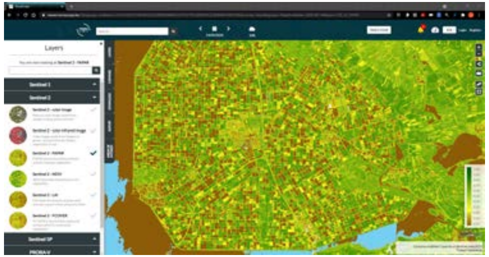
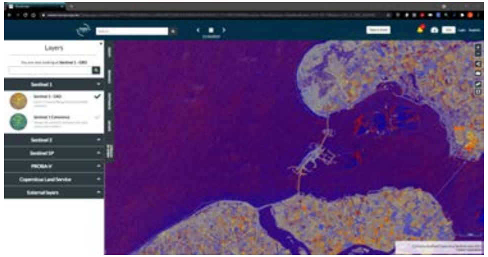
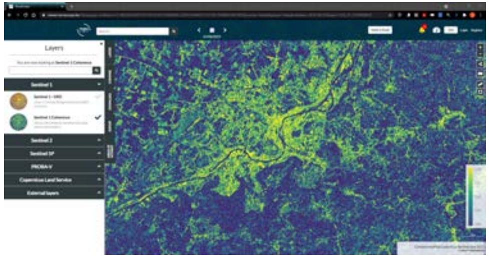
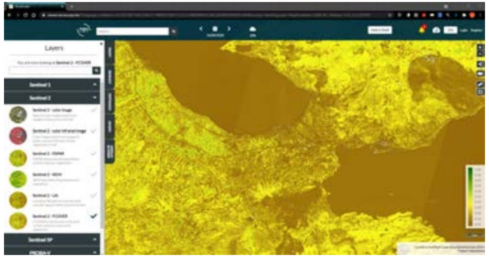
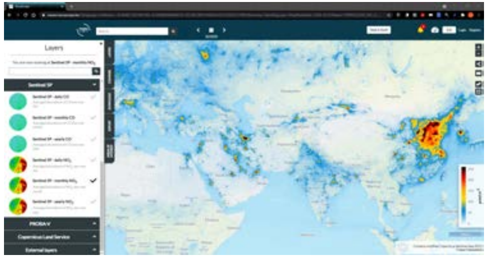
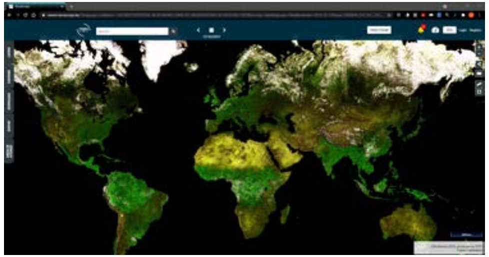
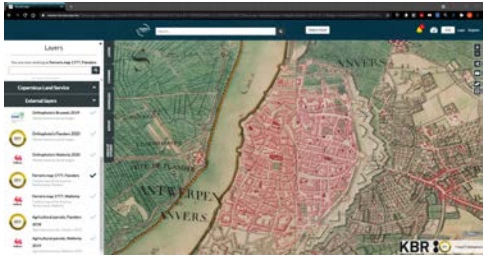
Base infrastructure: Terrascope

- Belgian Collaborative Ground Segment for Sentinel missions
- **Easy access** to
  - satellite data
  - products derived from satellite data
  - services (OGC web services, time series service)
  - cloud processing capacity (Jupyter Notebooks, Virtual Machines, openEO)
- **Enabling platform**
- Open for everyone (scientists, public authority, industry, citizens)
- **Free to use for everyone**
- Funded by BELSPO

vito
remote sensing

Terrascope Viewer

https://viewer.terrascope.be

Processing on Terrascope

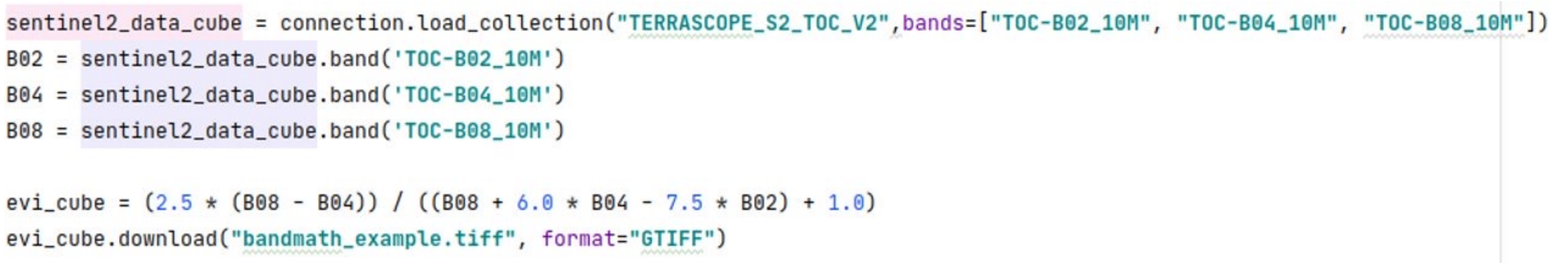
- Either on virtual machines/Jupyter
- Or write Spark/Dask job on Hadoop cluster
- Find products in catalog, access on disk

- Drawbacks:
  - VM's: limited
  - Spark: learn toolchain
  - File based processing is cumbersome
- EU: 40+ platforms with similar paradigms, but different

openEO: an EO processing standard

- 120 Process definitions: https://processes.openeo.org/
- Including 'User defined functions': leverage Python/R ecosystems
- Comprehensive web API
  - Data discovery (STAC)
  - Process discovery
  - Processing
  - Viewing services (OGC)
  - File/Result management,
  - openID connect
  - Sharing workflows as processes
- With simple Python + R API's

Simple band math



```
sentinel2_data_cube = connection.load_collection("TERRASCOPE_S2_TOC_V2",bands=["TOC-B02_10M", "TOC-B04_10M", "TOC-B08_10M"])
B02 = sentinel2_data_cube.band('TOC-B02_10M')
B04 = sentinel2_data_cube.band('TOC-B04_10M')
B08 = sentinel2_data_cube.band('TOC-B08_10M')

evi_cube = (2.5 * (B08 - B04)) / ((B08 + 6.0 * B04 - 7.5 * B02) + 1.0)
evi_cube.download("bandmath_example.tiff", format="GTIFF")
```

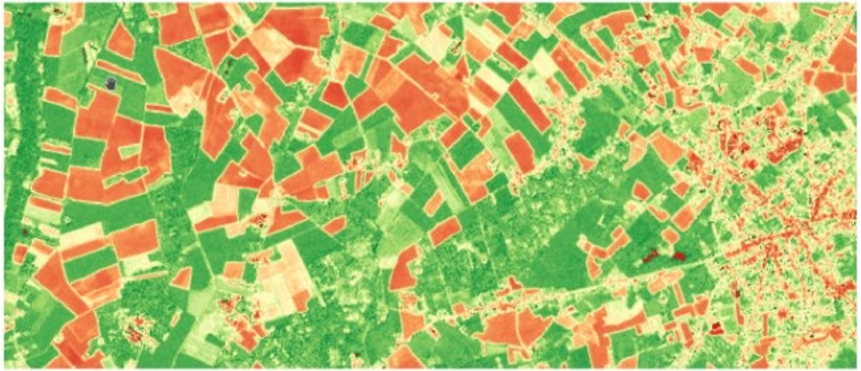
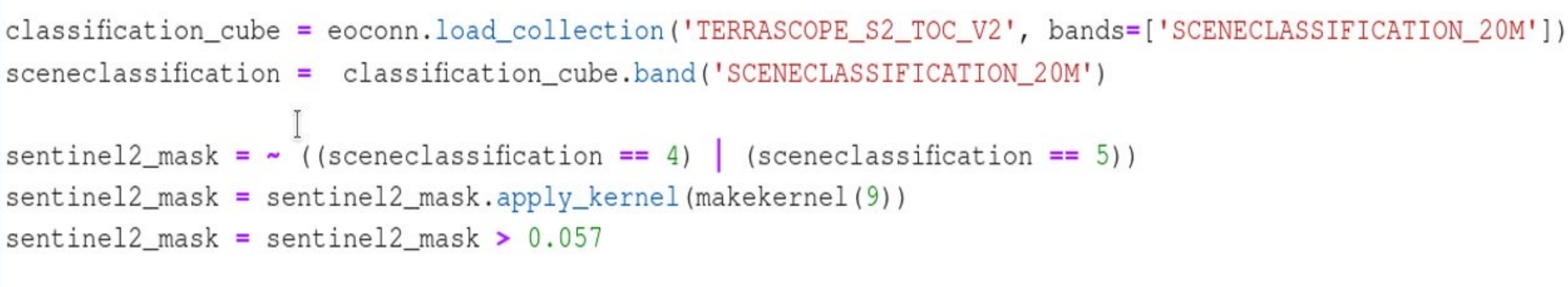
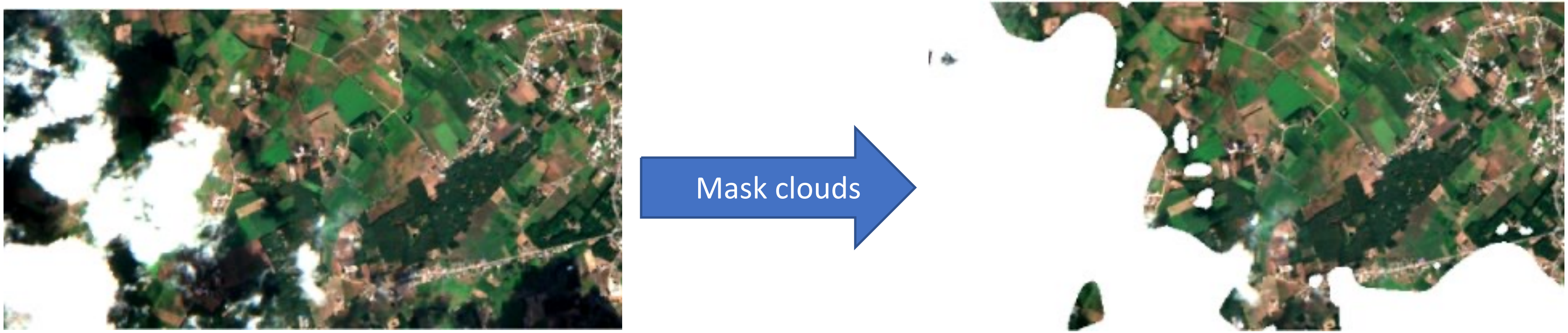


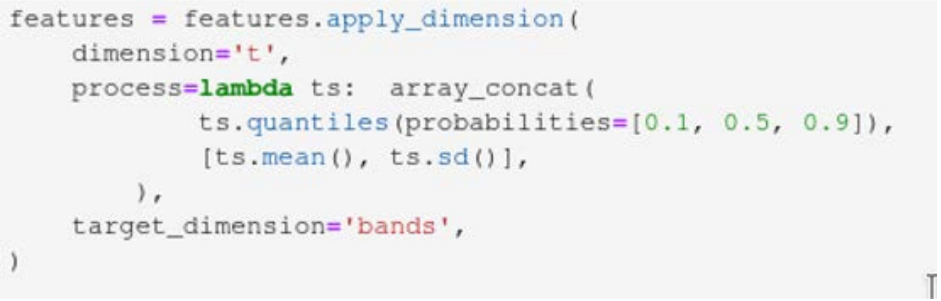
Image operations



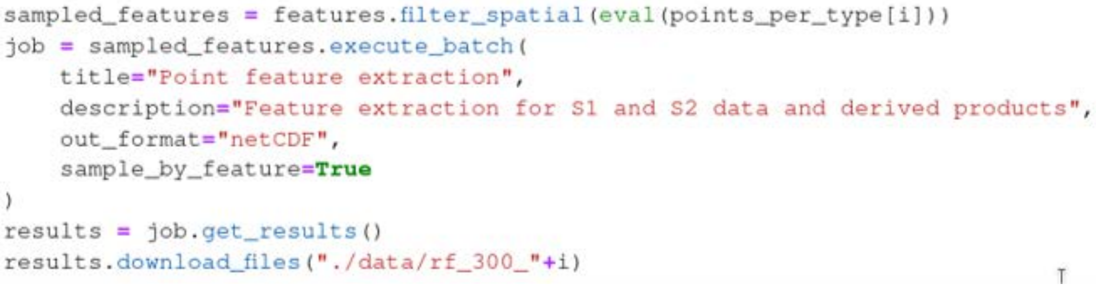
```
classification_cube = eoconn.load_collection('TERRASCOPE_S2_TOC_V2', bands=['SCENECLASSIFICATION_20M'])
sceneclassification =  classification_cube.band('SCENECLASSIFICATION_20M')

sentinel2_mask = ~ ((sceneclassification == 4) | (sceneclassification == 5))
sentinel2_mask = sentinel2_mask.apply_kernel(makekernel(9))
sentinel2_mask = sentinel2_mask > 0.057
```



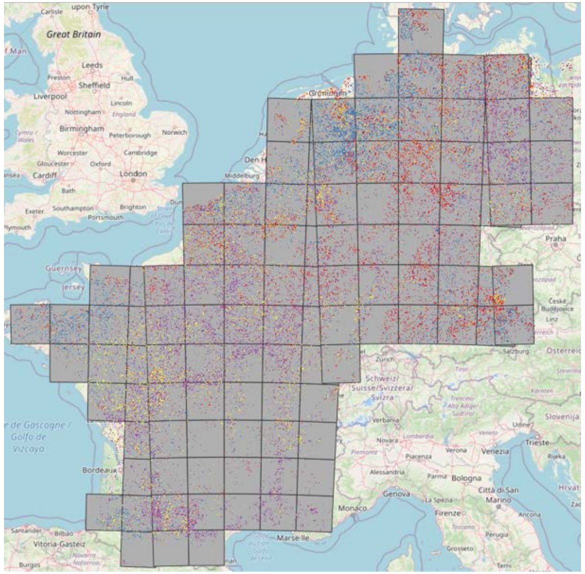
Crop classification



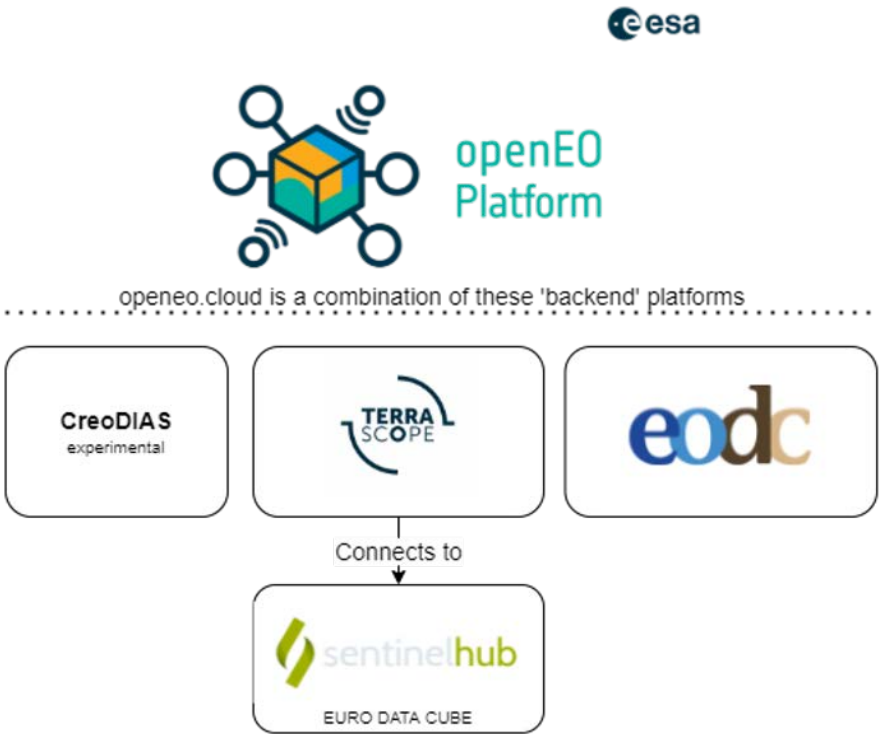
```
features = features.apply_dimension(
    dimension='t',
    process=lambda ts:  array_concat(
            ts.quantiles(probabilities=[0.1, 0.5, 0.9]),
            [ts.mean(), ts.sd()],
        ),
    target_dimension='bands',
)
```



```
sampled_features = features.filter_spatial(eval(points_per_type[i]))
job = sampled_features.execute_batch(
    title="Point feature extraction",
    description="Feature extraction for S1 and S2 data and derived products",
    out_format="netCDF",
    sample_by_feature=True
)
results = job.get_results()
results.download_files("./data/rf_300_"+i)
```



Federation: openEO platform



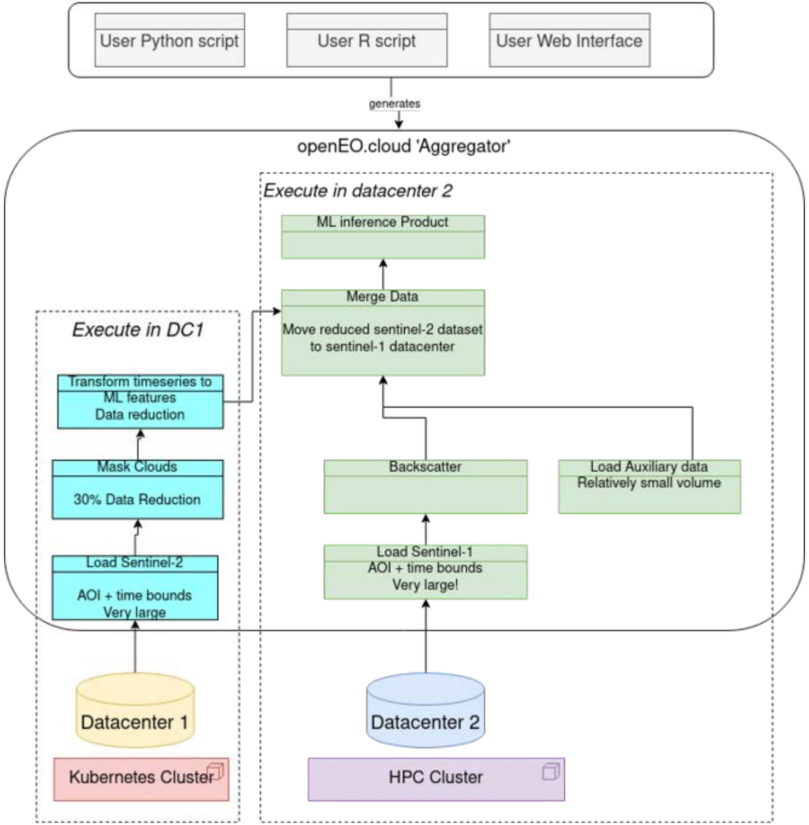
openeo.cloud is a combination of these 'backend' platforms

Federated processing

openEO structured workflows enable intelligent decisions:

Which datacenter has dataset X and process Y?

How to reduce data transfer?



User Python script

User R script

User Web Interface

generates

openEO.cloud 'Aggregator'

Execute in datacenter 2

ML inference Product

Merge Data

Move reduced sentinel-2 dataset to sentinel-1 datacenter

Execute in DC1

Transform timeseries to ML features
Data reduction

Mask Clouds

30% Data Reduction

Load Sentinel-2

AOI + time bounds
Very large

Backscatter

Load Auxiliary data
Relatively small volume

Load Sentinel-1
AOI + time bounds
Very large!

Datacenter 1

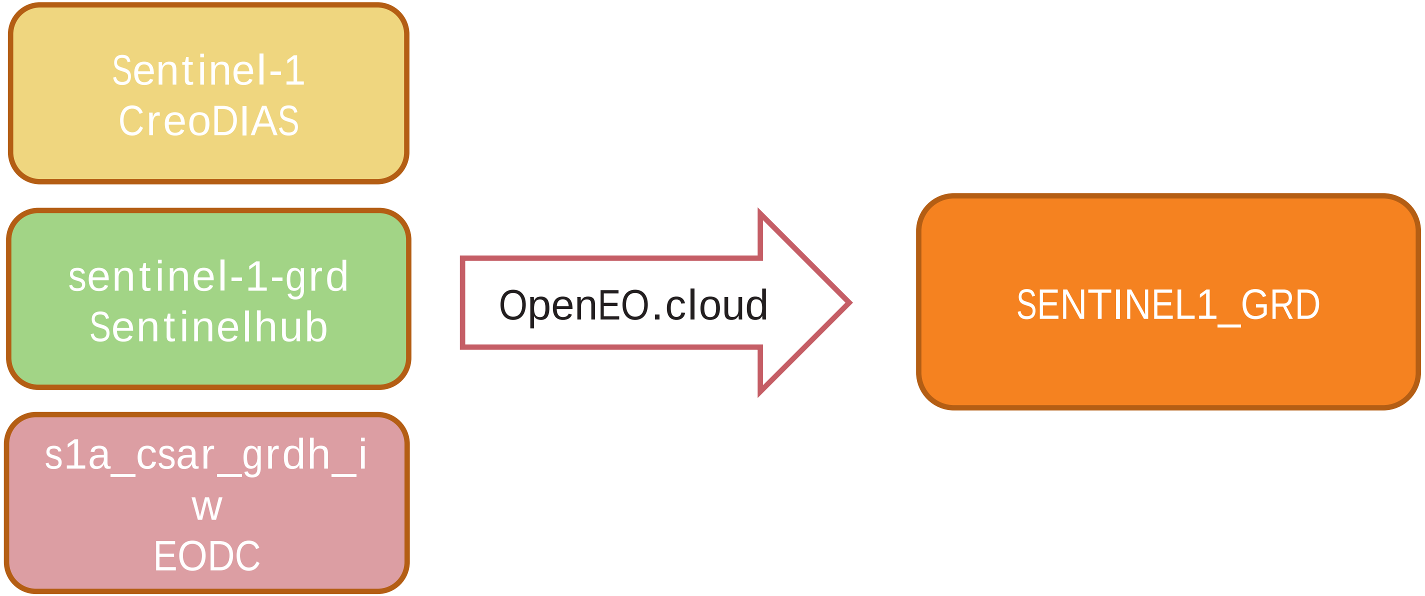
Datacenter 2

Kubernetes Cluster

HPC Cluster

Federation: Data harmonization

Same collection – multiple names



Sentinel-1
CreoDIAS

sentinel-1-grd
Sentinelhub

s1a_csar_grdh_i
w
EODC

OpenEO.cloud

SENTINEL1_GRD

Interested?

- Motivated early adopters can apply for account:
  - https://openeo.cloud/early-adopters/
- C-Scale also testing openEO on other providers