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SPACE TO INNOVATE

EVDC for EarthCARE

evdc
esa eo validation data centre

esa

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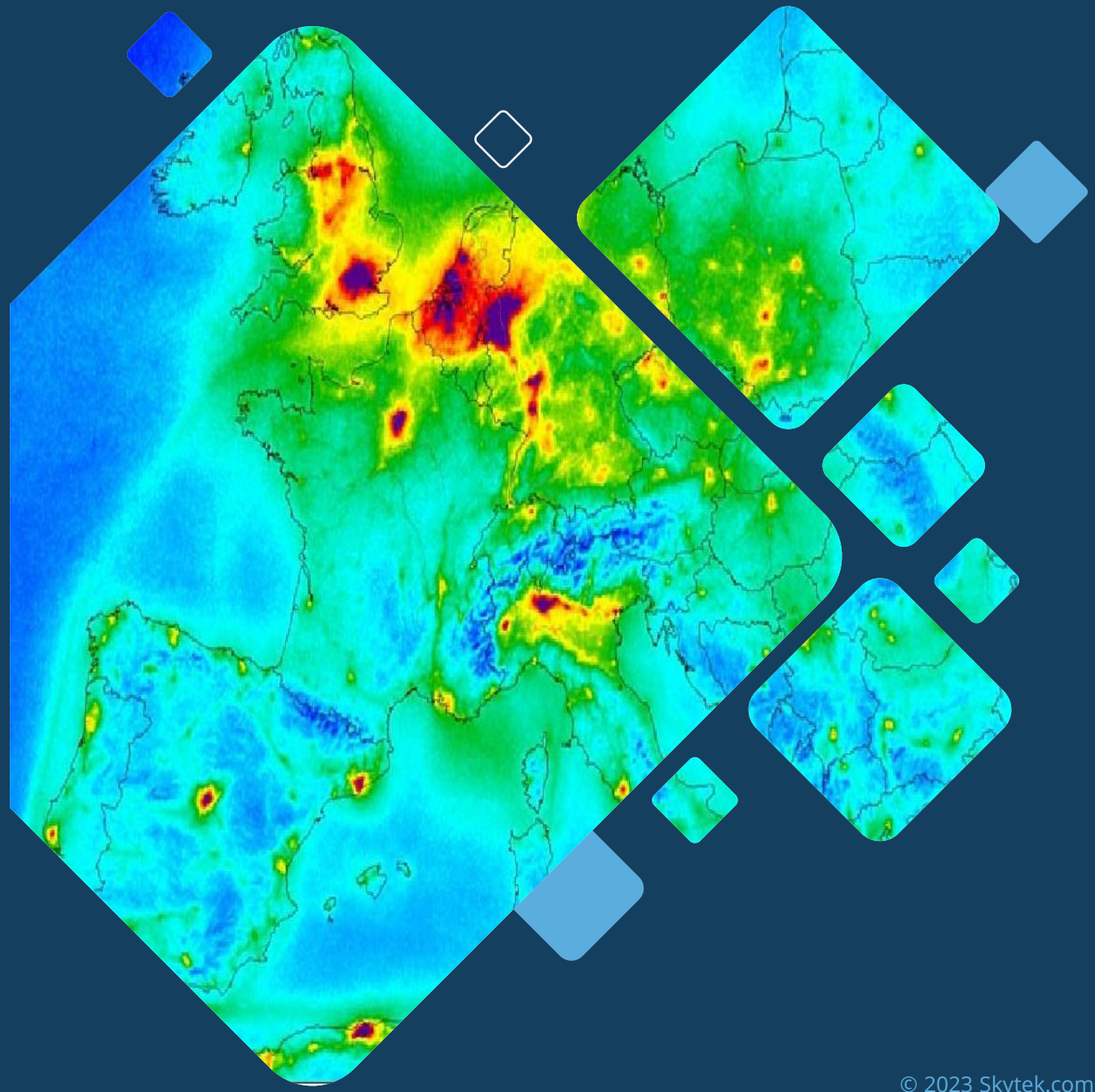
AGENDA

28/06/2023
(15:00 CET)

- 15:00 Introduction to Satellite Data Archive on EVDC
- 15:15 CIS tool interface and use case
- 15:35 ALTLID and MSI L1 tools integration to EVDC
- 16:00 5 mins break?
- 16:05 Collocation Database
- 16:25 Orbit Prediction and overpass tool
- 16:45 Q & A



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Introduction to satellite archive on EVDC

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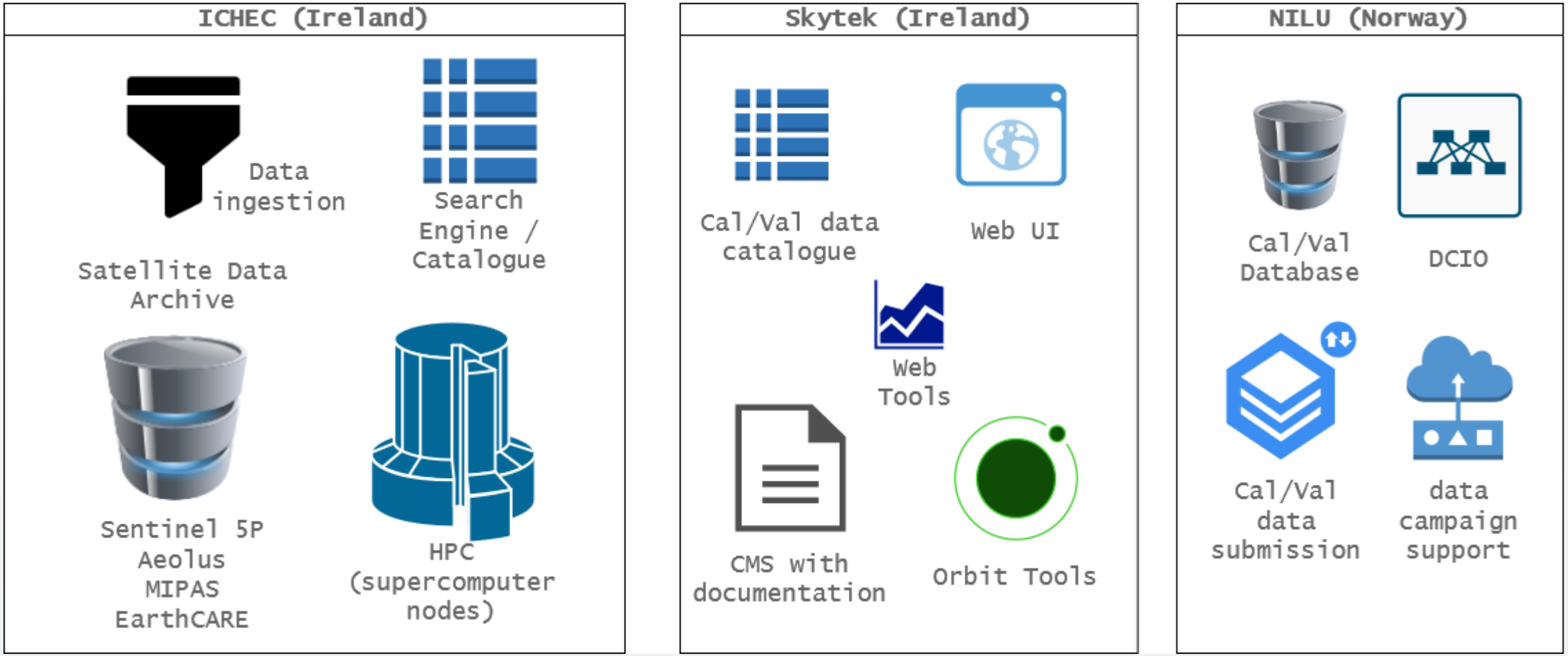
EVDC – Platform Overview



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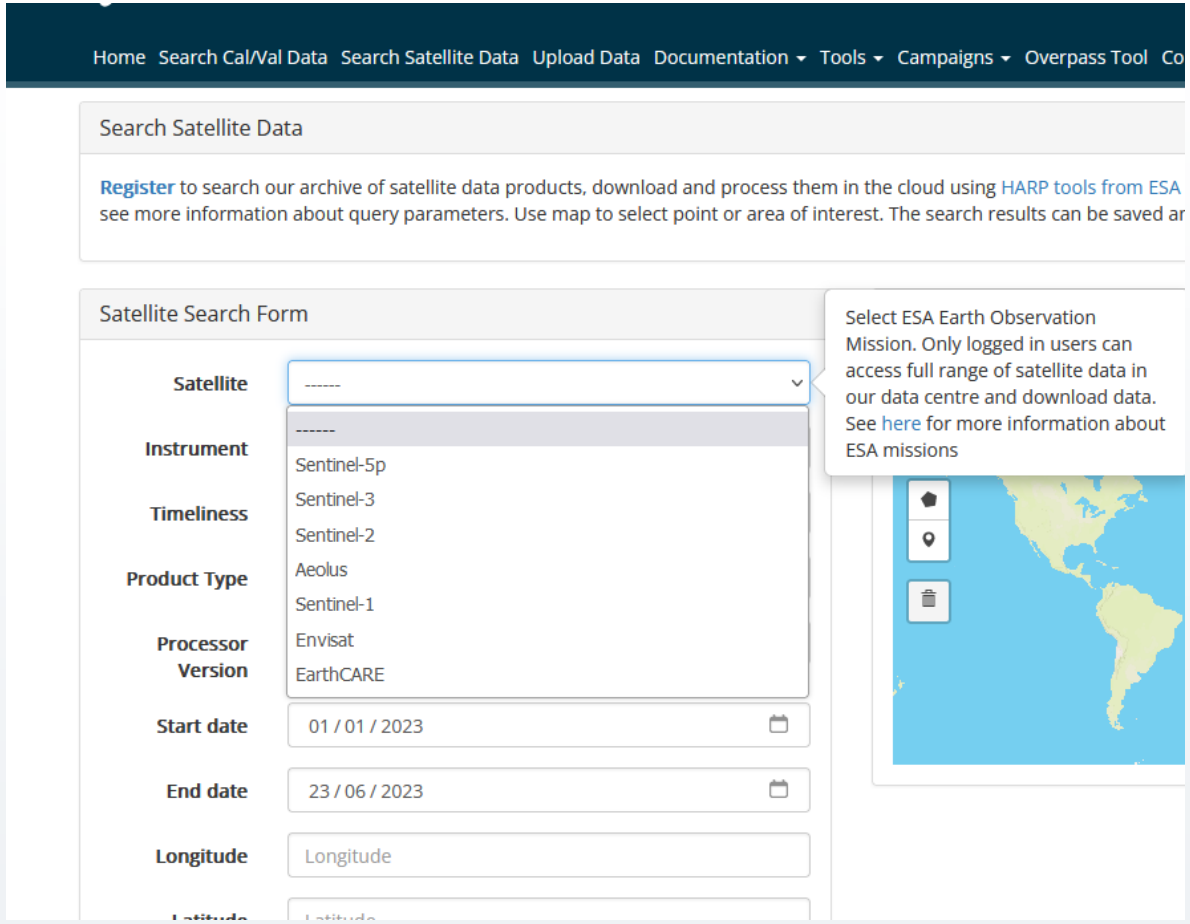
EVDC – Satellite data archive

Available atmospheric mission data (approx 500TB)

- Sentinel 5P
- Aeolus
- MIPAS (Envisat)
- **Future EarhCARE**

Access

- **https://evdc.esa.int**
- **Registration required (NILU u/p is sufficient)**



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EVDC – Satellite data search engine/catalogue

- **Product ingestion and indexing services**
- **Fast, enterprise grade search engine (Solr)**
- **Spatial search functionalities**

view-source:https://space.kay.ichec.ie/search?family_name=EarthCARE

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EVDC – Satellite data search UI

Satellite Search Form

Satellite	Sentinel-5p
Instrument	TROPOMI
Timeliness	--------
Product Type	S5P_NRTI_L2__O3____
Processor Version	--------
Start date	01 / 01 / 2023
End date	27 / 06 / 2023
Longitude	-7.107275,-5.238902,-5.249893,-7.085294
Latitude	53.842481,53.842481,52.898631,52.739285

★ Submit

Select Point or Polygon

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EVDC – Satellite data search UI

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Satellite	Sentinel-5p
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★ Submit

Search Terms

Select Point or Polygon

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EVDC – Satellite data search UI

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Select Point or Polygon

Select point or polygon

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★ Submit

Select Point or Polygon

Draw

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EVDC – Satellite data search UI

Satellite Search Form

Satellite	Sentinel-5p
Instrument	TROPOMI
Timeliness	--------
Product Type	S5P_NRTI_L2__O3____
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Longitude	-7.107275,-5.238902,-5.249893,-7.085294
Latitude	53.842481,53.842481,52.898631,52.739...

★ Submit

Select Point or Polygon

Submit

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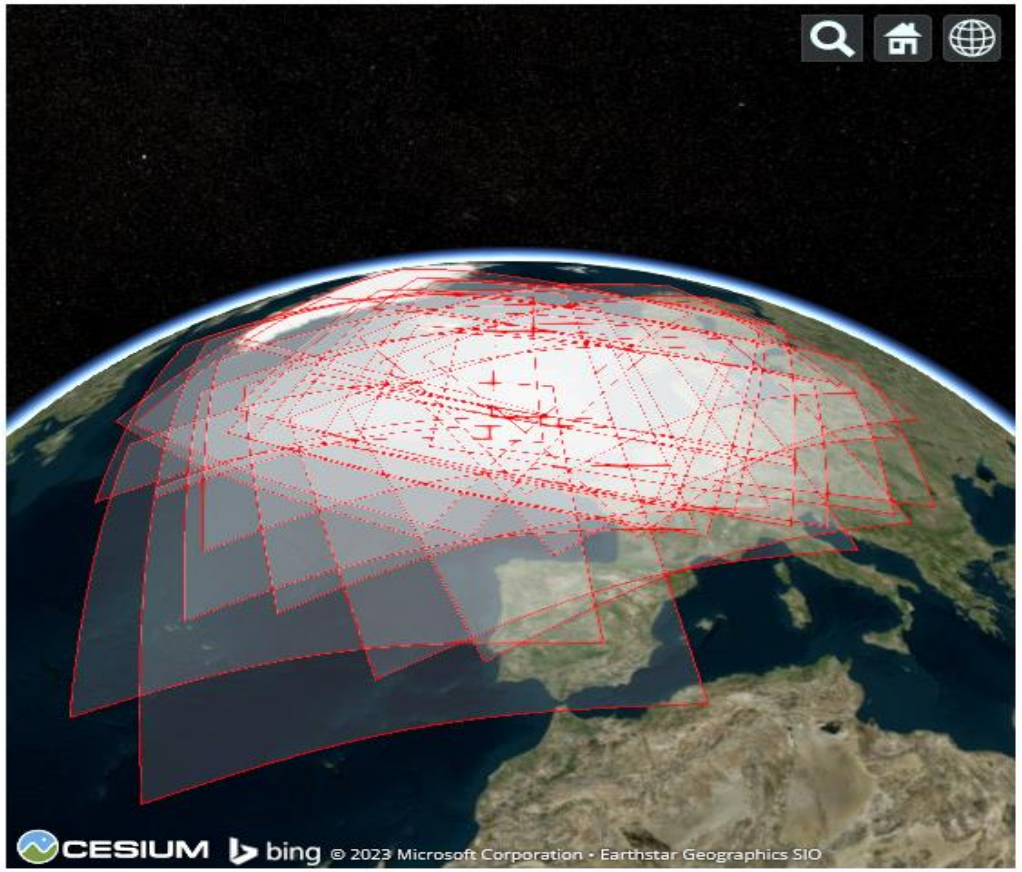
EVDC – Satellite data search UI

Search Query

Satellite	Sentinel-5p
Instrument	TROPOMI
Timeliness	
Product Type	S5P_NRTI_L2__SO2___
Processor Version	
Start date	2023-01-01
End date	2023-06-27
Longitude	-6.865494,-6.074183,-6.063193,-6.975398
Latitude	53.732141,53.719141,52.779176,52.805750

Refine search

World View of Search Results



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EVDC – Satellite data search UI

Page 1 out of 6 (132 Results)

1 | Go To Page | Save Search and Process Results | Save the search results to access the data processing capabilities (subsetting, merging, viewing metadata). | < | >

Thumbnail	File Name	Size (MB)	Created	Satellite Name	Instrument
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EVDC – Satellite data search UI

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1 | Go To Page | Save Search and Process Results | Save the search results to access the data processing capabilities (subsetting, merging, viewing metadata). | < | >

Thumbnail	File Name	Size (MB)	Created	Satellite Name	Instrument
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	S5P_NRTI_L2__SO2____20230613T120849_20230613T121349_29355_03_02040...	111	2023-06-13T12:13:56Z	Sentinel-5p	TROPOMI
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Click to download directly

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EVDC – Satellite data search UI

Page 1 out of 6 (132 Results)

1 | Go To Page | Save Search and Process Results | Save the search results to access the data proce

Thumbnail	File Name				
	S5P_NRTI_L2__SO2___20230613T134849_20230613T135349_29356_03_02040...				
	S5P_NRTI_L2__SO2___20230613T120849_20230613T121349_29355_03_02040...	111	2023-06-13T12:13:56Z	Sentinel-5p	TROPOMI
	S5P_NRTI_L2__SO2___20230613T035849_20230613T040349_29350_03_02040...	29	2023-06-13T04:03:56Z	Sentinel-5p	TROPOMI

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Completed — 11.8 MB

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Completed — 14.9 MB

S5P_NRTI_L2__SO2___20230613T...03_020401_20230613T040321.nc
Completed — 14.9 MB

Show all downloads

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Page 1 out of 6 (132 Results)

1 | Go To Page | Save Search and Process Results | Save the search results to access the data processing capabilities (subsetting, merging, viewing metadata). | < | >

Select products of interest

Thumbnail	File Name	Size (MB)	Created	Satellite Name	Instrument
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	S5P_NR…T134849_20230613T135349_29356_03_02040…	112	2023-06-13T13:53:56Z	Sentinel-5p	TROPOMI
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	S5P_NRTI_L2__SO2____20230613T021849_20230613T022349_29349_03_02040…	14	2023-06-13T02:22:34Z	Sentinel-5p	TROPOMI

Save

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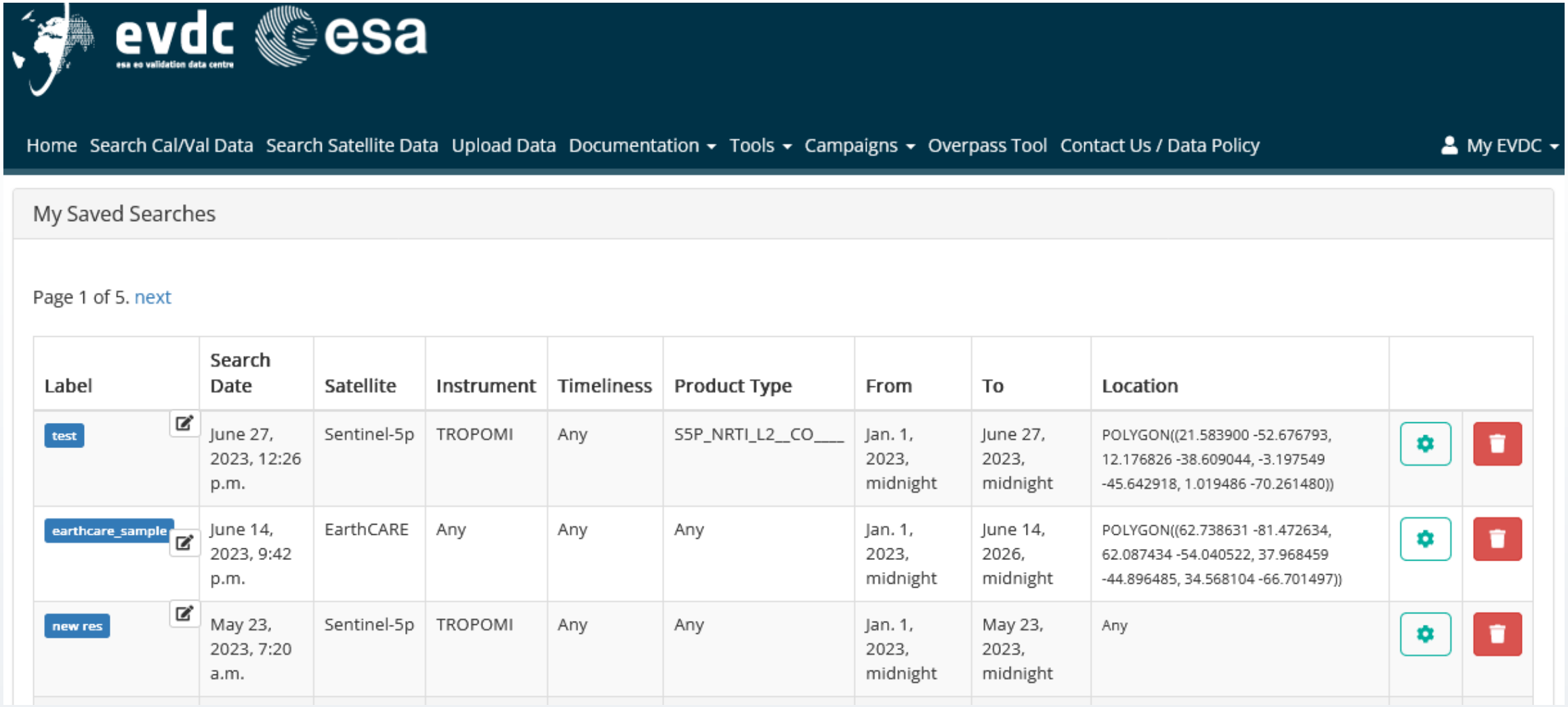
EVDC – Satellite data search UI



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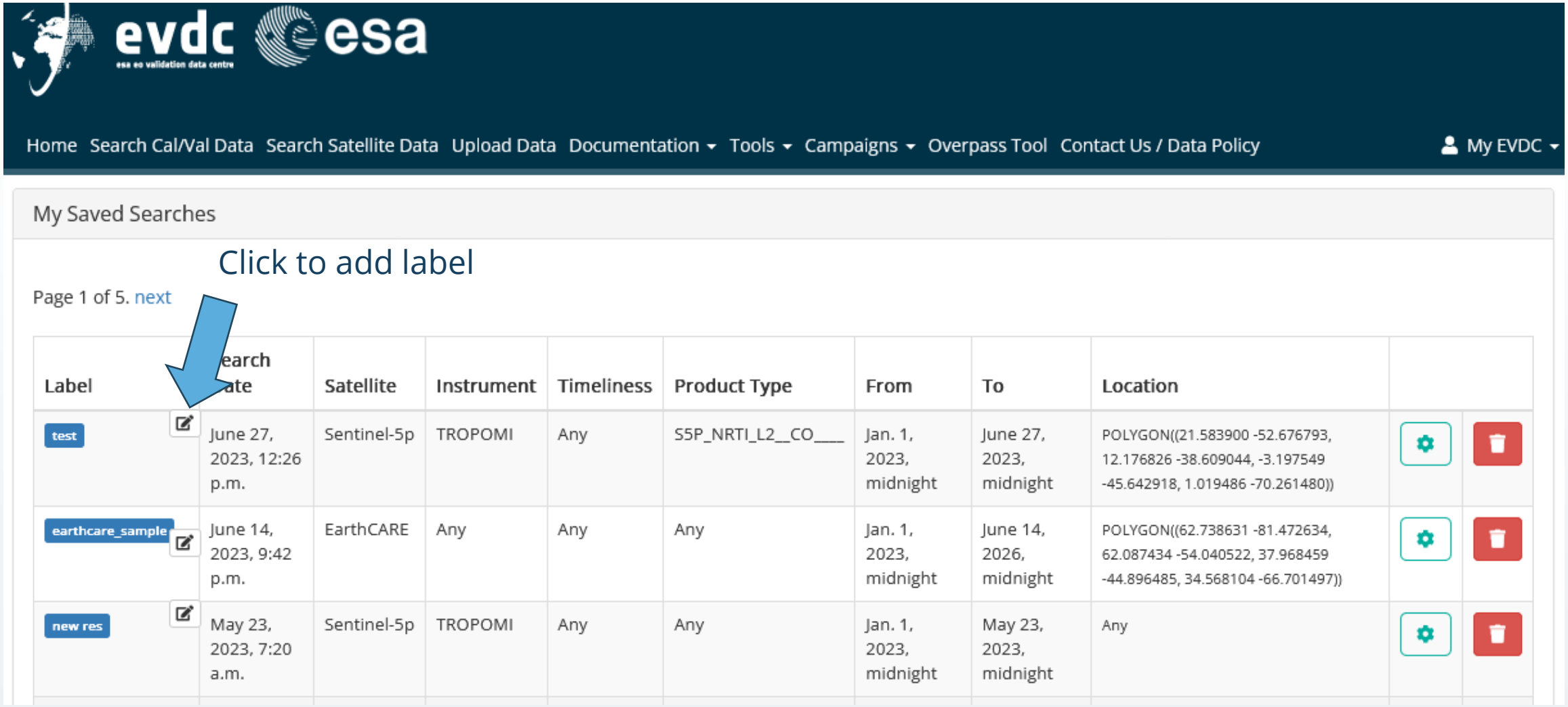
EVDC – Satellite data search UI



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EVDC. Saving Satellite Data and Staging Satellite Data

- **Saving files** – a simple mechanism for grouping and tagging the files for futher processing.
- For EarthCARE saving will also mean **staging files** for processing
- Because of the nature of staging mechanism there will be restrictions and quotas on how much data user can stage
- We envisage allowing big data processing tasks on request
- In the long term the ESA's strategy of single data source will be followed and so the files will be staged from the primary source (DIAS etc.)
- In the initial phase after launch we envisage to store everything and serve as early access point for catalogued EarthCare data fronted by the search engine

☐		ECA_EXOA_AUX_JSG_1D_20241231T223802Z_20160222T091641Z_39319A.zip	24	2024-12-31T22:49:37Z	EarthCARE
☐		ECA_EXAA_BMA_FLX_2B_20241231T223802Z_20210929T141544Z_39316D.zip	3	2024-12-31T22:49:37Z	EarthCARE
☐		ECA_EXAA_BM__RAD_2B_20241231T223802Z_20210923T164500Z_39316D.zip	7	2024-12-31T22:49:37Z	EarthCARE
☐		ECA_EXAA_BMA_FLX_2B_20241231T223802Z_20210929T141544Z_39316D.zip	3	2024-12-31T22:49:37Z	EarthCARE
☐		ECA_EXAA_BM__RAD_2B_20241231T223802Z_20210923T164500Z_39316D.zip	7	2024-12-31T22:49:37Z	EarthCARE

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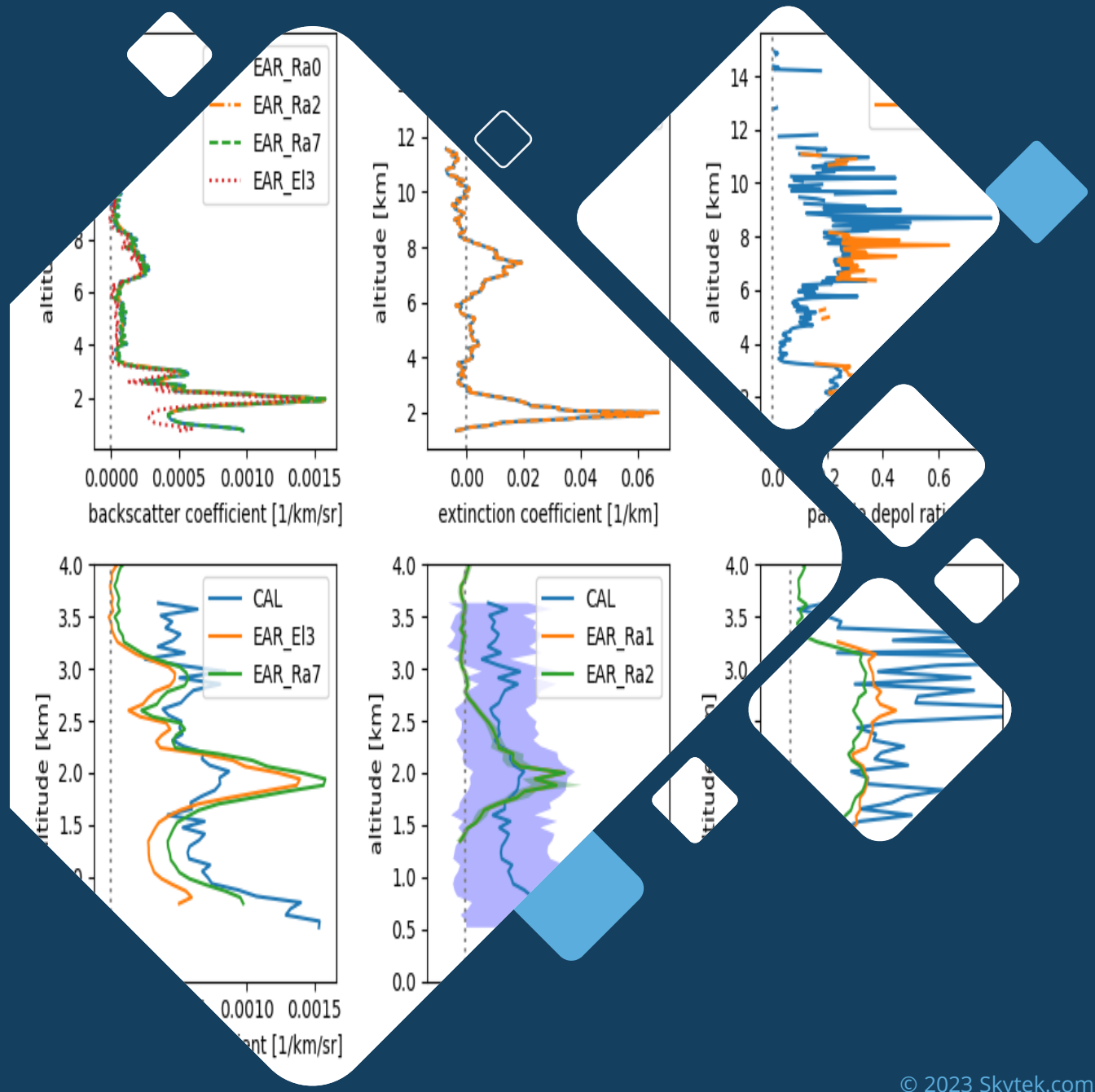

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CIS, CLM, MSI tools and use cases

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esa

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EVDC Processing System and CWL

- New processing system is based on CWL
- CWL – standard way to describe analysis pipelines to make them **portable** and **reusable**.
- CWL is designed to meet the needs of data-intensive science, such as Bioinformatics, Medical Imaging, Astronomy, High Energy Physics, and Machine Learning.
- Adopted by EO community, recommended by OGC, included in EOEPCA

COMMON WORKFLOW LANGUAGE

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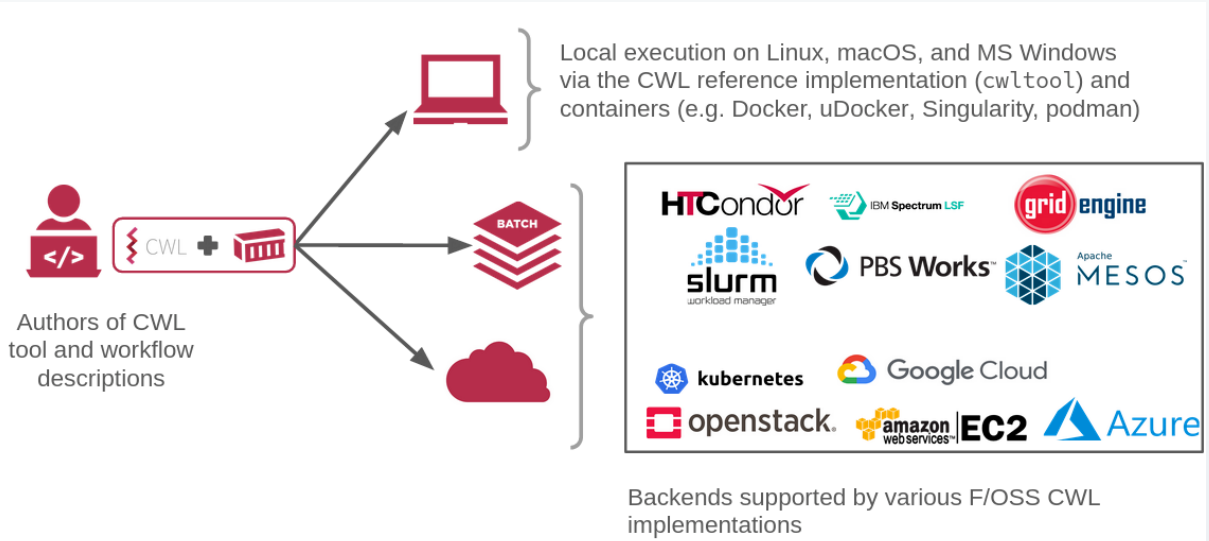
EVDC Processing System and CWL

CWL Goals

- To express every possible analytic workflow as a graph of command line tools invocations
- To handle passing the files and values between workflows
- To be able to run identical workflows on many different environments using special runners (local machine, AWS,




```
#!/usr/bin/env cwl-runner

cwlVersion: v1.2
# This CommandLineTool executes the linux "harpmerge" command-line tool.

class: CommandLineTool
baseCommand: harpmerge

inputs:
  in1:
    type: File
    inputBinding:
      position: 1
  in2:
    type: File
    inputBinding:
      position: 2
  out:
    type: string
    inputBinding:
      position: 3
outputs:
  results:
    outputBinding:
      glob: '*.nc'
      outputEval: $(self.path.replace(/.nc$/, '/output.nc'))
    type: File
hints:
  DockerRequirement:
    dockerPull: evdc2harp
requirements:
  EnvVarRequirement:
    envDef:
      PATH: usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
  ResourceRequirement: {}
  InlineJavascriptRequirement: {}

stdout: output/files/output.txt
```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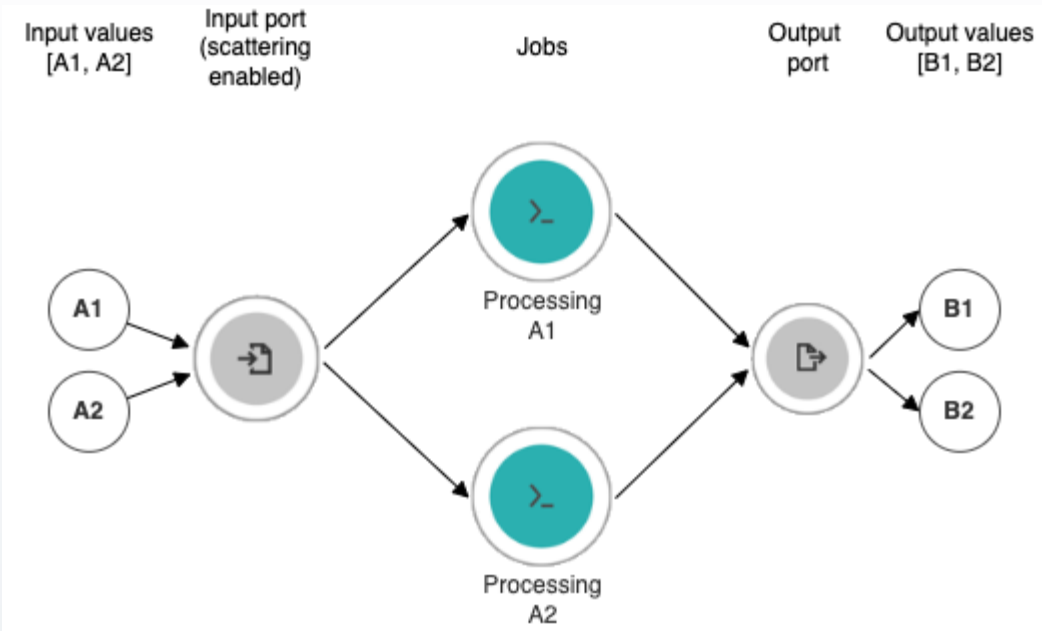
EVDC Processing System and CWL

Parallelization and scaling

- To express every possible analytic workflow as a graph of command line tools invocations
- To handle passing the files and values between workflows
- To be able to run identical workflows on many different environments using special runners (local machine, AWS,



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EVDC Processing System and CWL

- CWL is powerful but how to make CWL more accessible?
- How to make it more reusable between researchers
- How to hide some of its complexities and provide good defaults for generic cases

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    type: File
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  DockerRequirement:
    dockerPull: evdc2harp
requirements:
  EnvVarRequirement:
    envDef:
      PATH:
usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
  ResourceRequirement: {}
  InlineJavascriptRequirement: {}

stdout: output/files/output.txt
```


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EVDC Processing System and CWL

```
harpmerge file1.nc file2.nc output.nc
```

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#!/usr/bin/env cwl-runner

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      position: 2
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    type: string
    inputBinding:
      position: 3
outputs:
  results:
    outputBinding:
      glob: '*.nc'
      outputEval: $(self.path.replace(/.nc$/, '/output.nc'))
    type: File
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    dockerPull: evdc2harp
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  ResourceRequirement: {}
  InlineJavascriptRequirement: {}

stdout: output/files/output.txt
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EVDC Processing System and CWL

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  ResourceRequirement: {}
  InlineJavascriptRequirement: {}

stdout: output/files/output.txt
```

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EVDC Processing System and CWL

Visual representation of arbitrary command line tool

```
harpmerge file1.nc file2.nc output.nc
```

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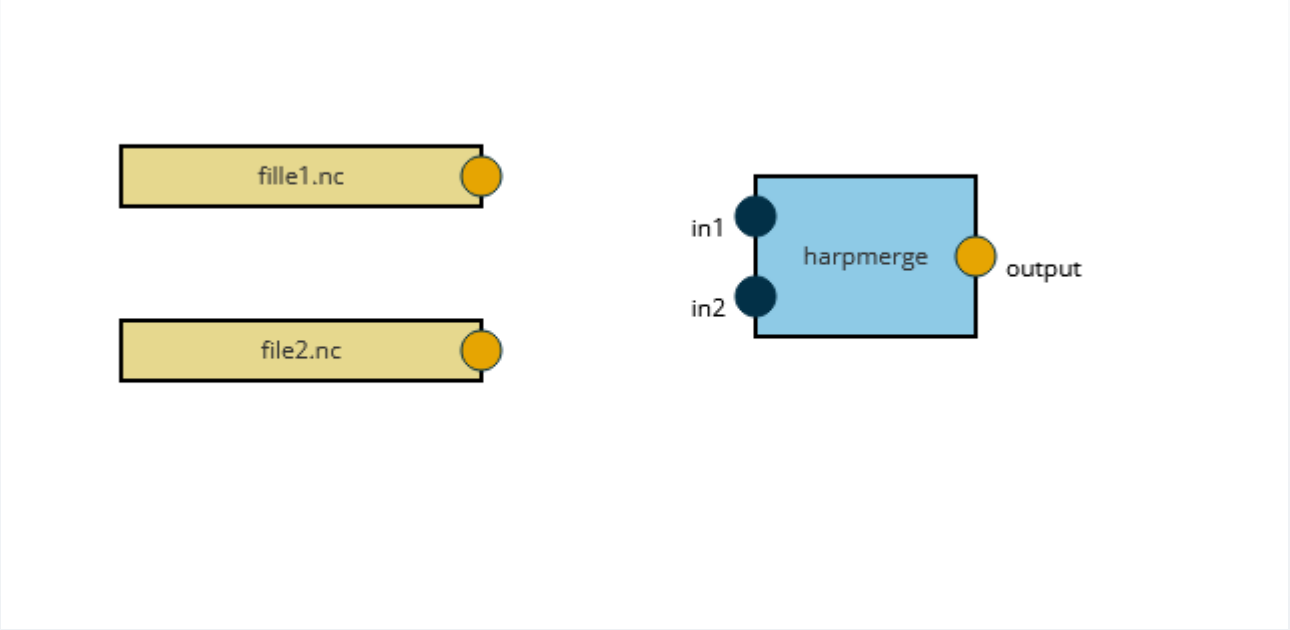
EVDC Processing System and CWL

Adding input files

```
harpmerge file1.nc file2.nc output.nc
```



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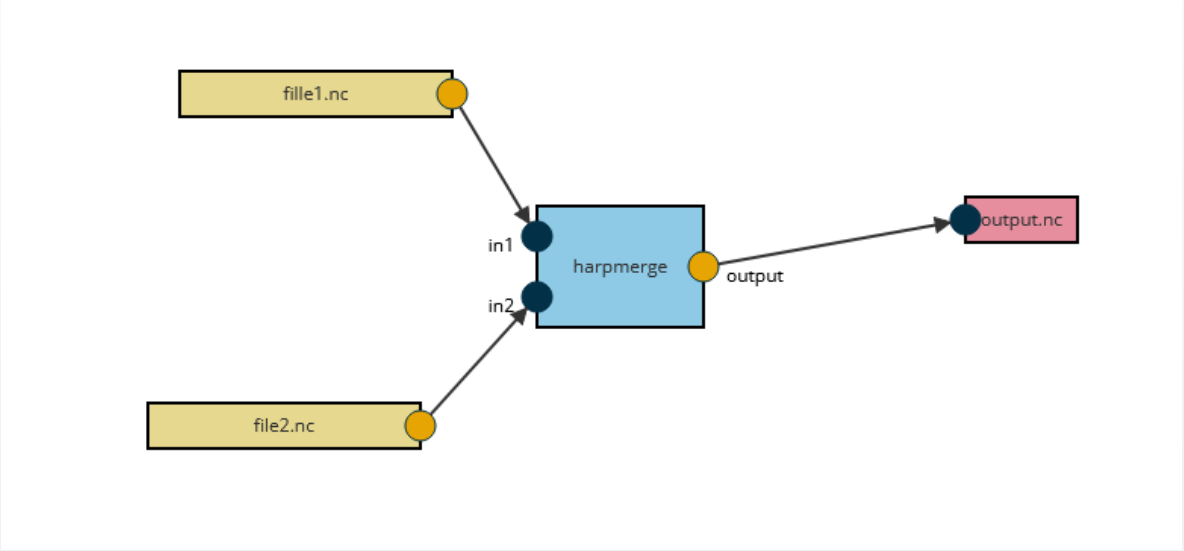
EVDC Processing System and CWL

Graph representing simple command line tool invocation

```
harpmerge file1.nc file2.nc output.nc
```



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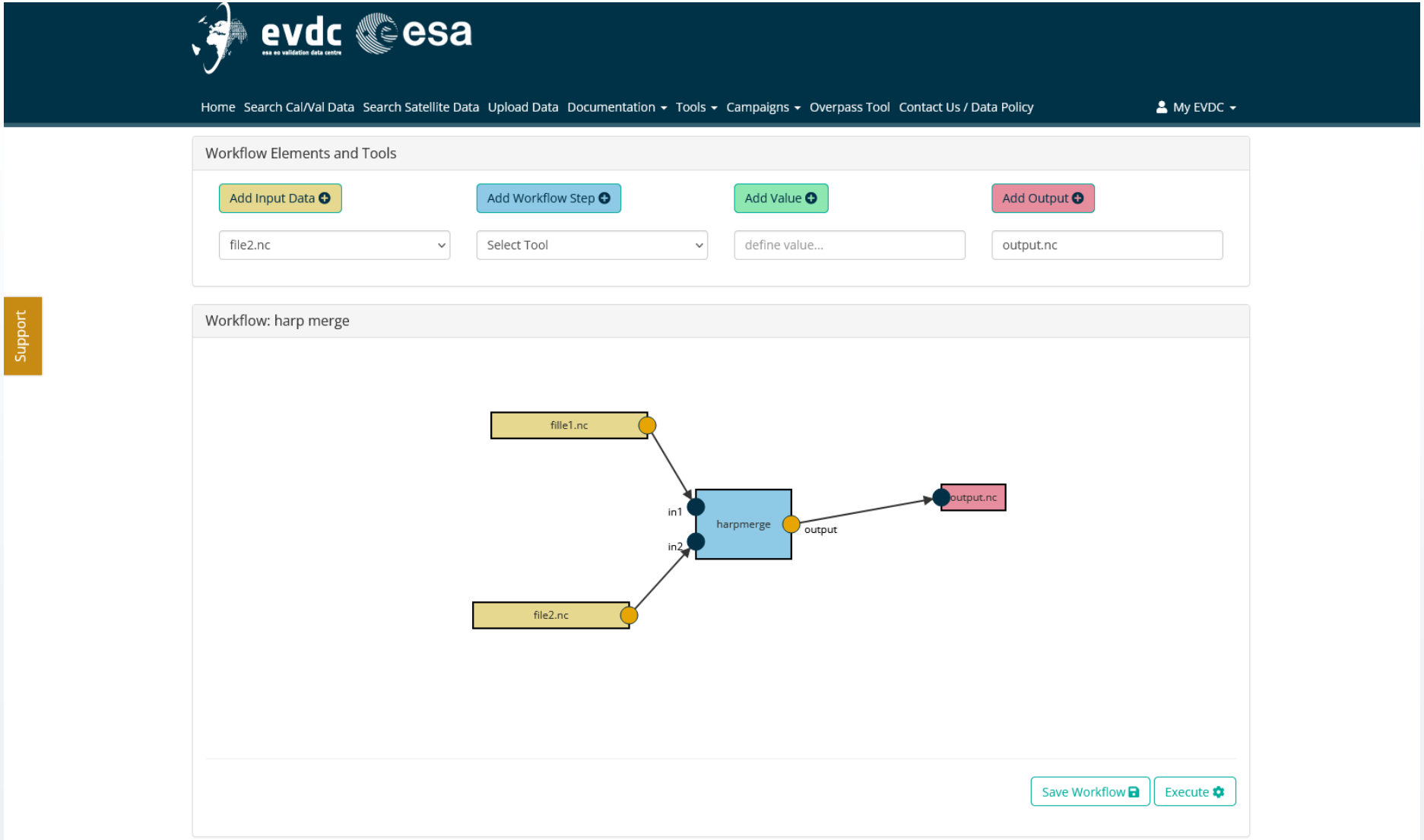
EVDC Processing System and CWL



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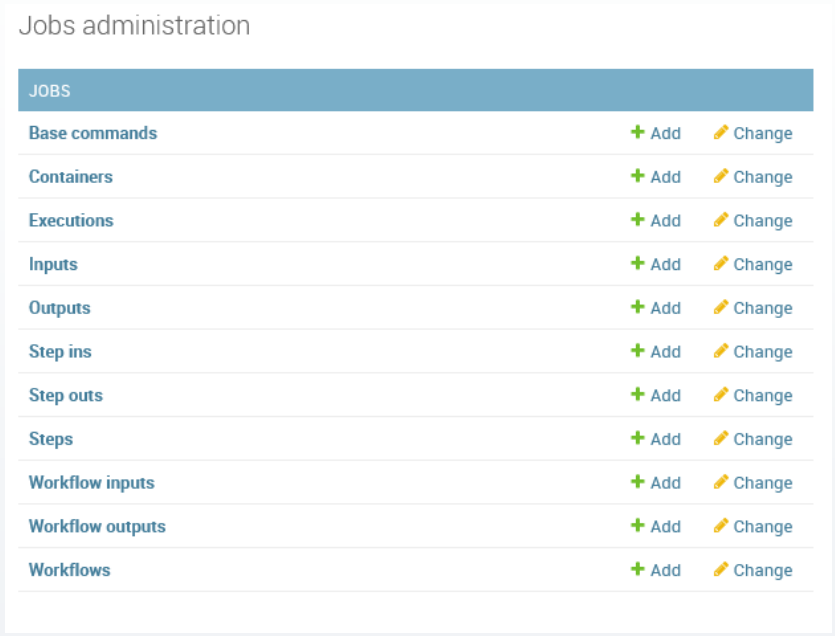
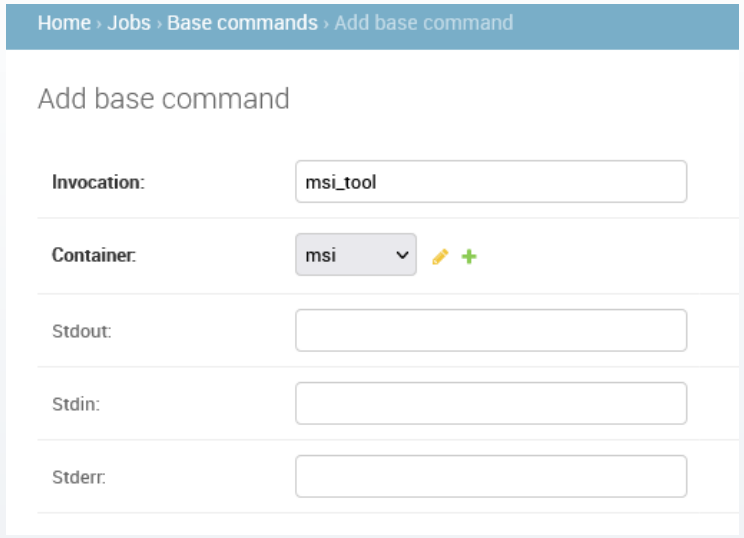
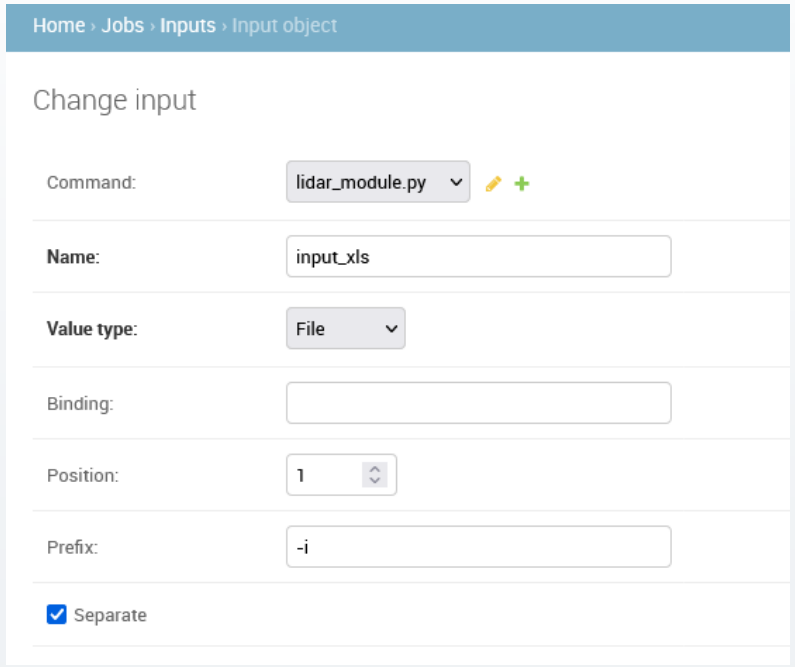
EVDC Processing System and CWL

Admin tools – defining commands, inputs and outputs







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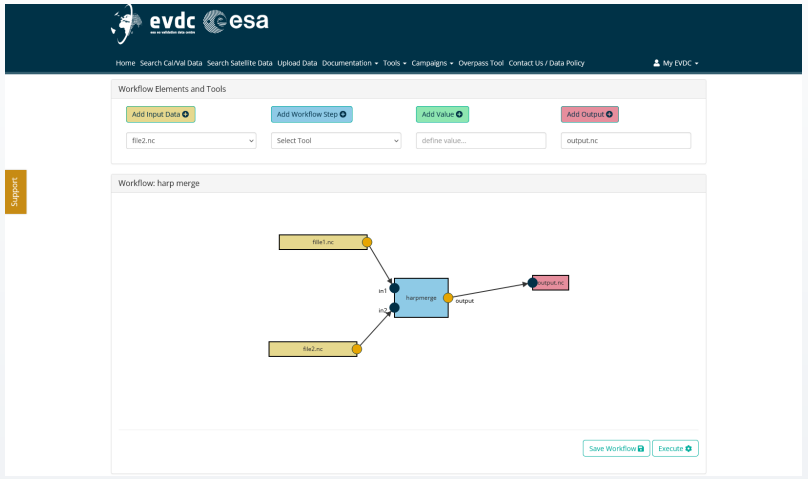
CIS EVDC Processing System and CIS

Processing infrastructure




```
#!/usr/bin/env cwl-runner

cwlVersion: v1.2
# This CommandLineTool executes the linux
"harpmerge" command-line tool.

class: CommandLineTool
baseCommand: harpmerge

inputs:
  in1:
    type: File
    inputBinding:
      position: 1
  in2:
    type: File
    inputBinding:
      position: 2
  out:
    type: string
    inputBinding:
      position: 3
outputs:
  results:
    outputBinding:
      glob: '*.nc'
      outputEval: $(self.path.replace(/.nc$/,
'/output.nc'))
    type: File
hints:
  DockerRequirement:
    dockerPull: evdc2harp
requirements:
  EnvVarRequirement:
    envDef:
      PATH:
usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/
sbin:/bin
  ResourceRequirement: {}
  InlineJavascriptRequirement: {}

stdout: output/files/output.txt
```

COMMON WORKFLOW LANGUAGE

API

CWL Runner

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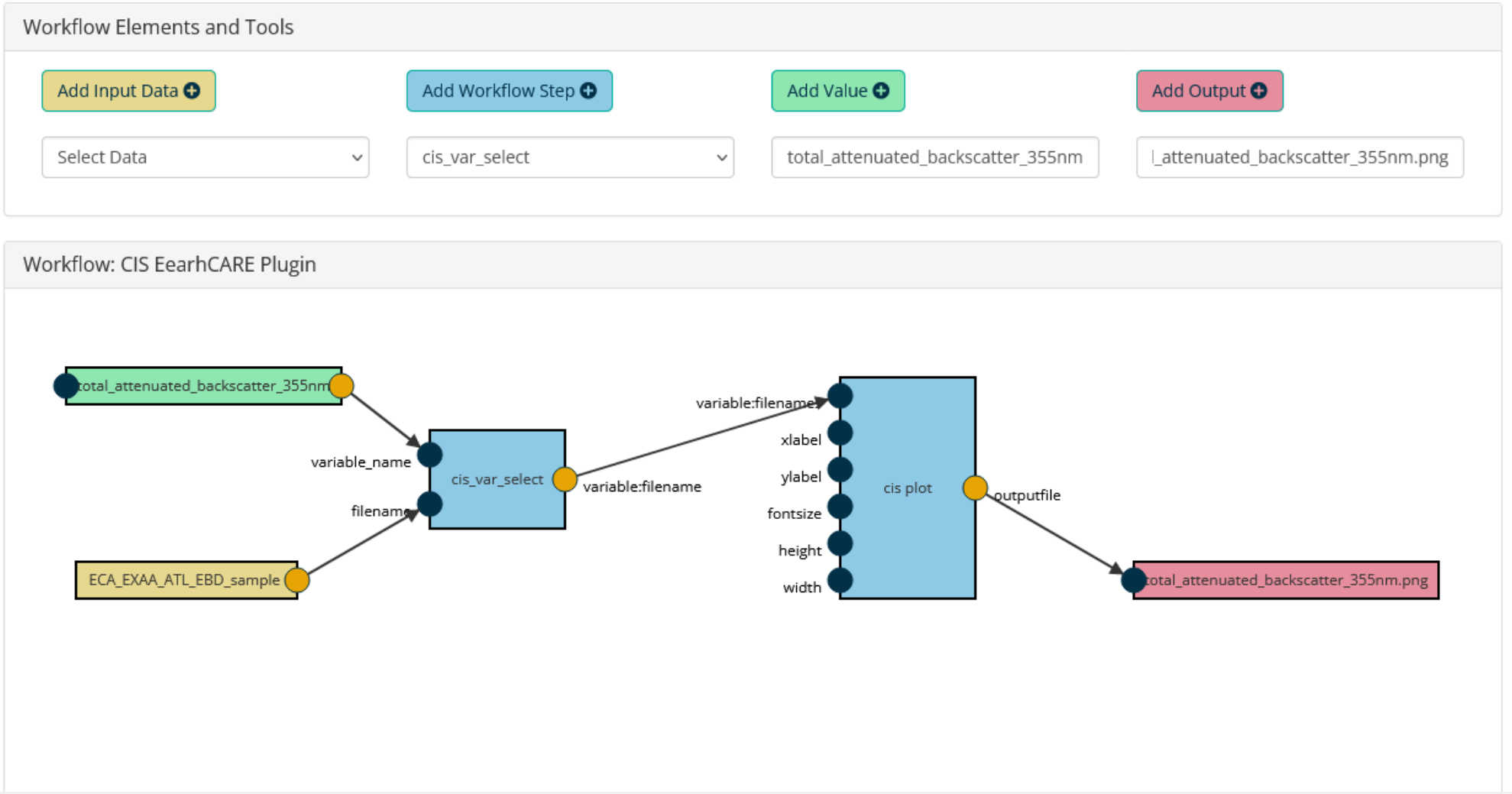
CIS Tool. EarthCARE plugin (reader)



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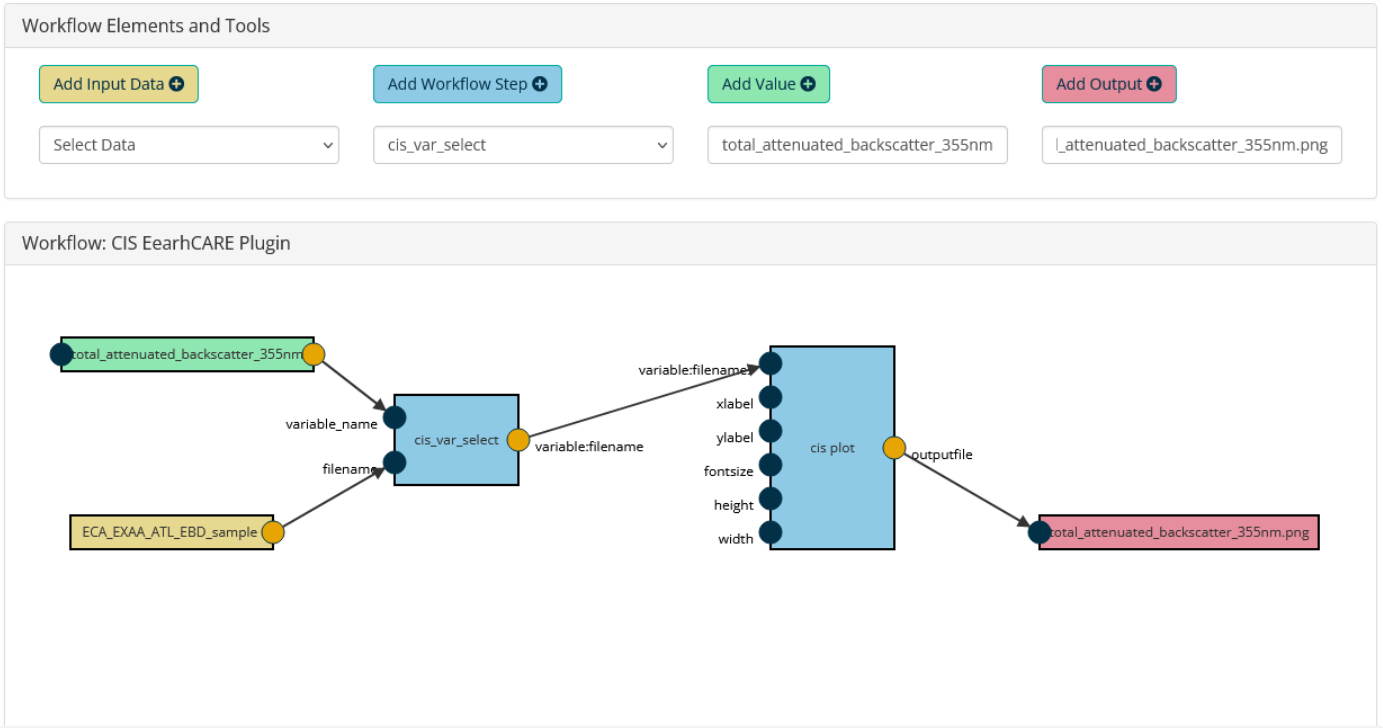
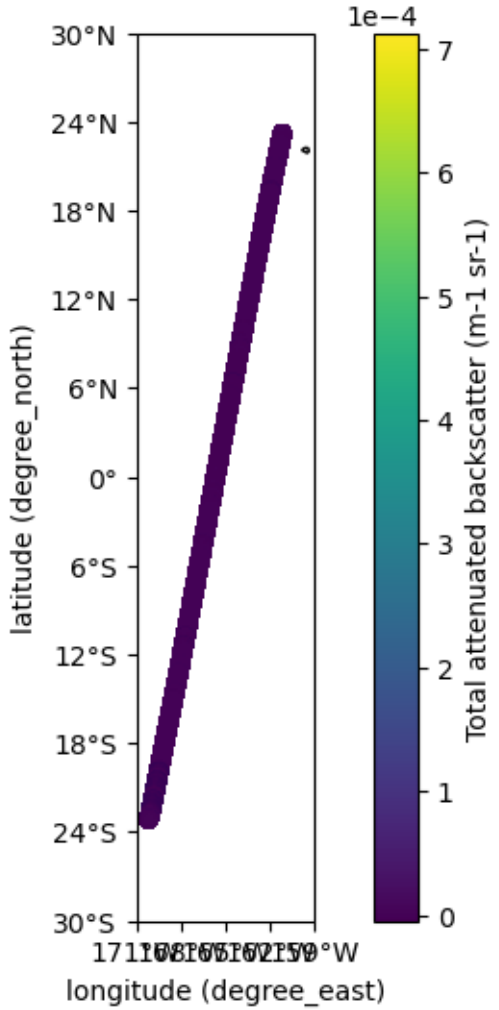
CIS Tool. EarthCARE plugin (reader)





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CIS Tool. EarthCARE plugin (reader)

The Plugin Status:

- Plugin is currently written for ALT and MSI products (with some exclusions)
- Automated test script for generating default plots of all possible variables of all test products
- Some product types generate errors from underlying NetCDF library
- Issue currently investigated
- Once fixed plugin to be pushed to the main CIS repository

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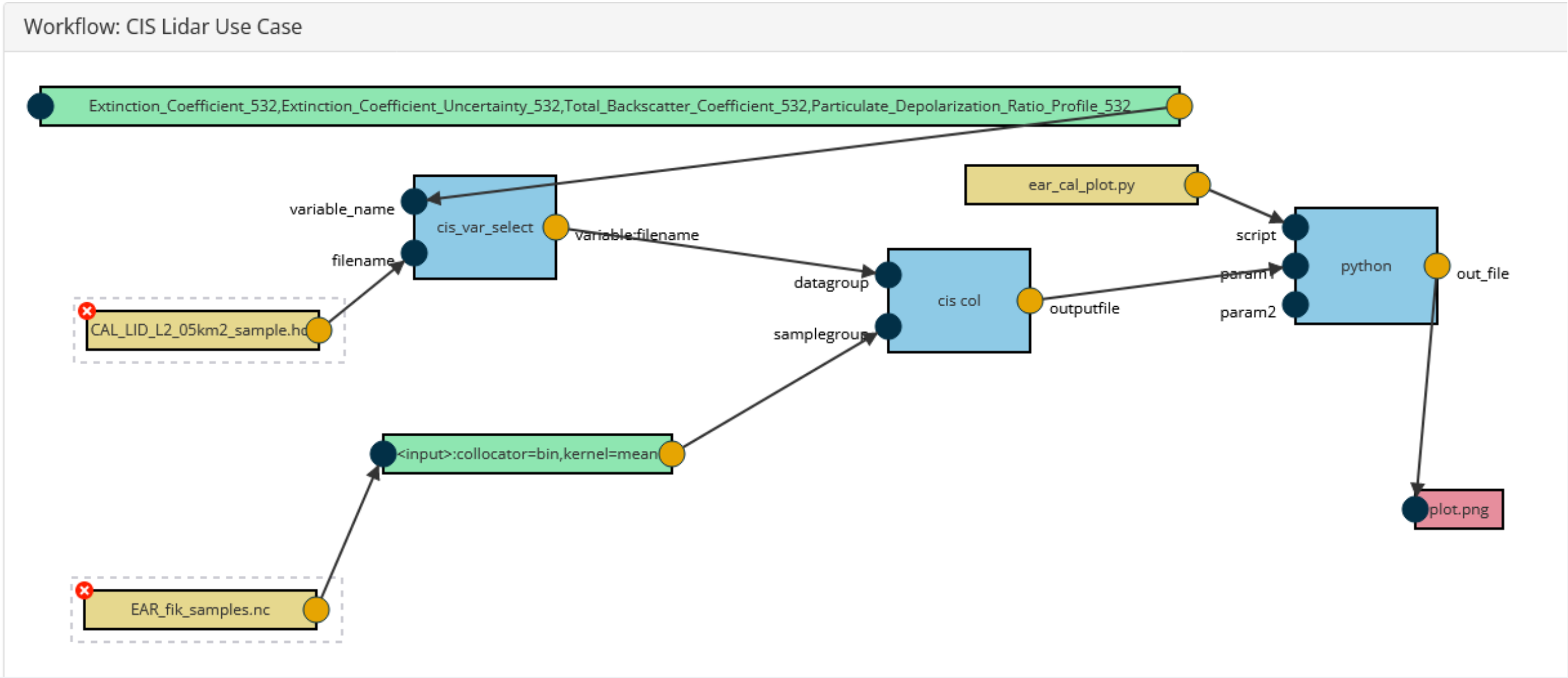
CIS Tool. More practical use case



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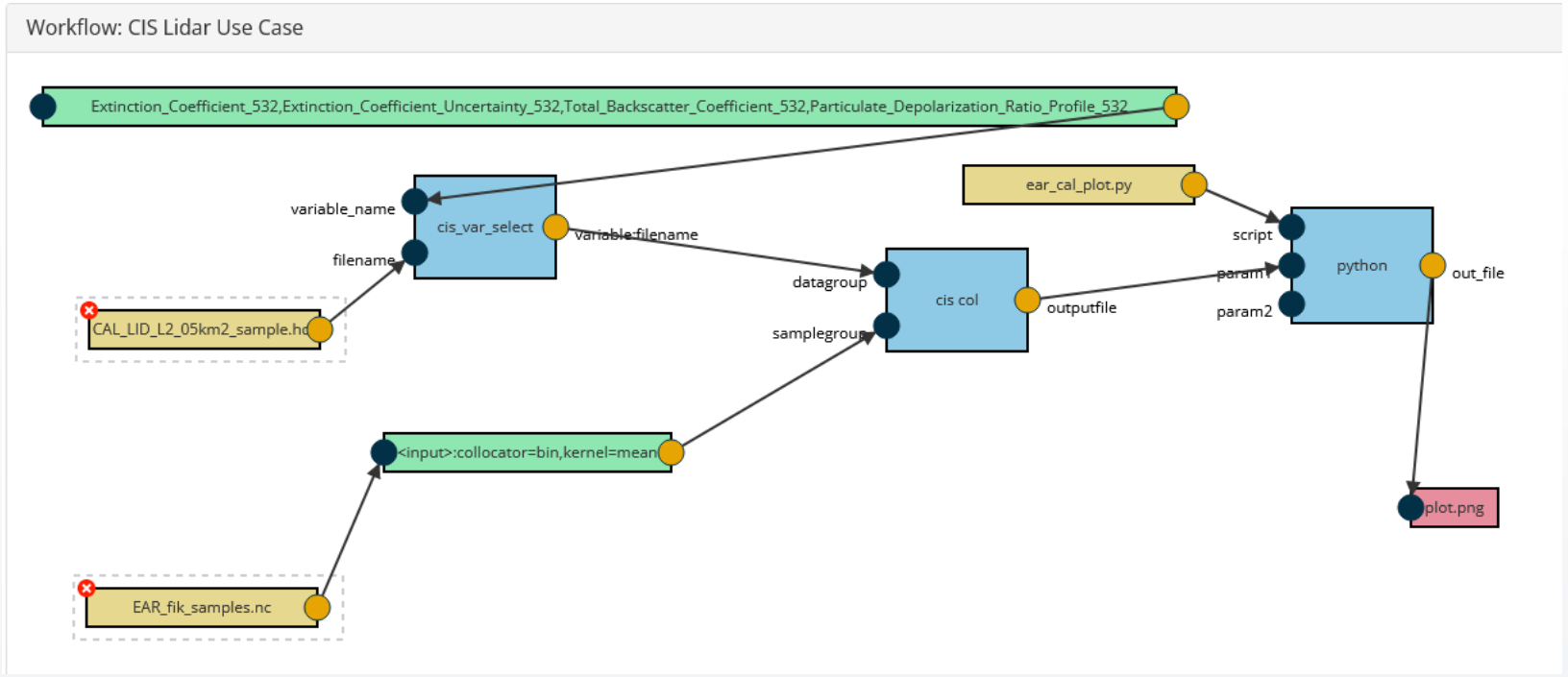
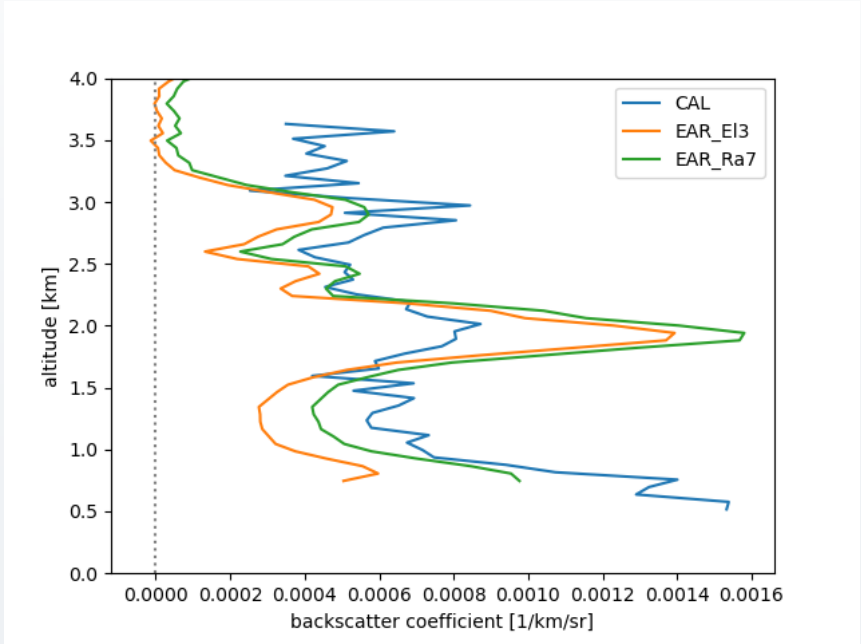
CIS Tool. More practical use case





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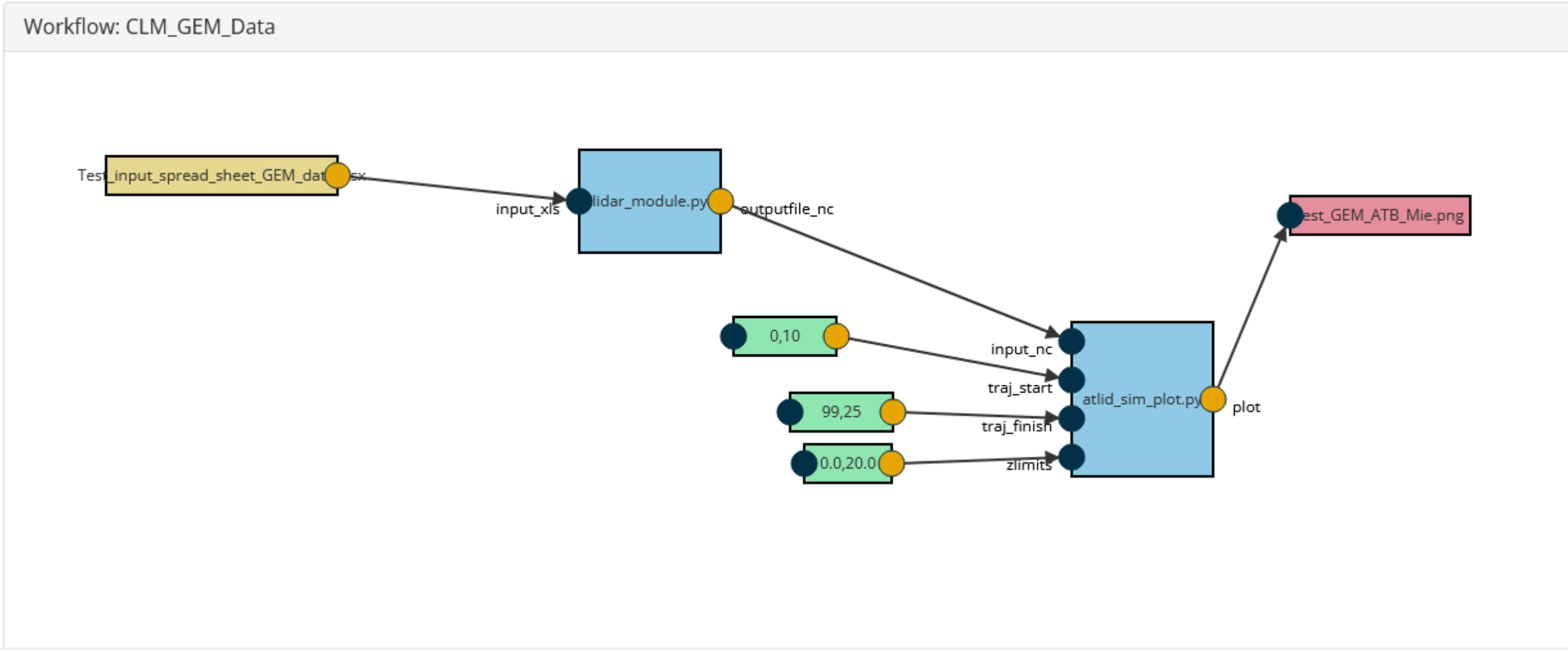
CLM. Lidar Tool Example



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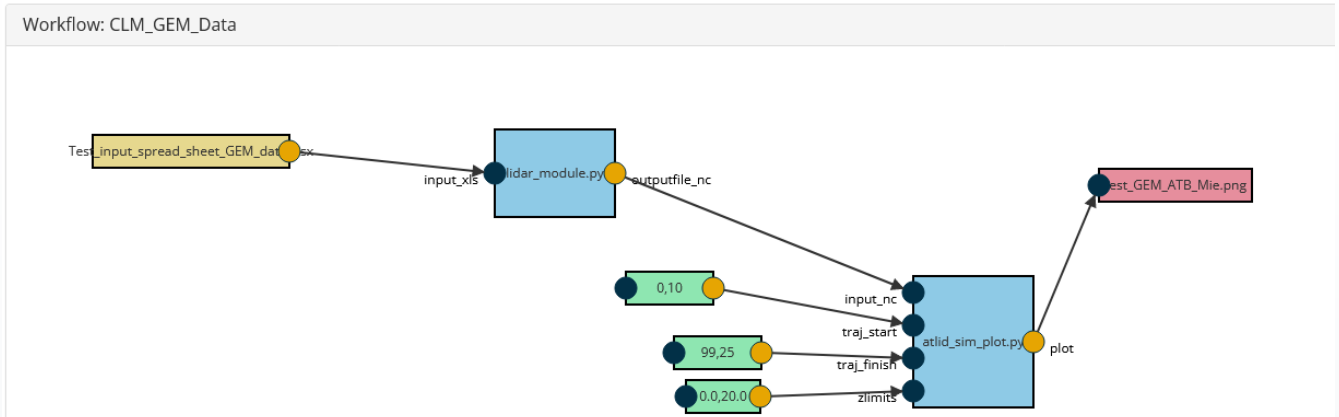
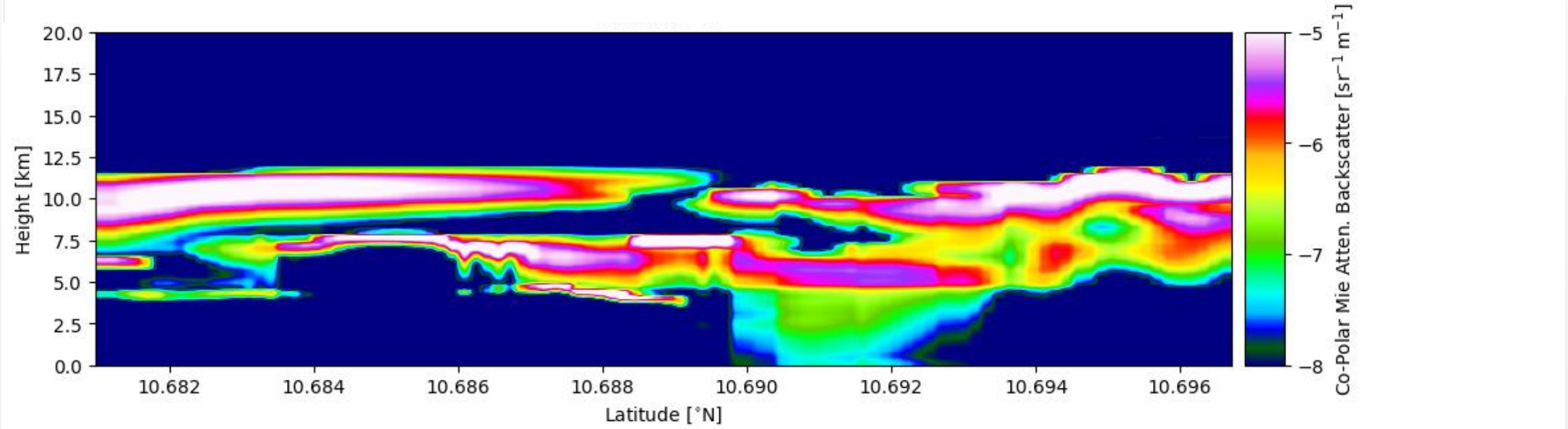
CLM. Lidar Tool Example





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MSI Tool Example

```
msi_tool -i ice_cloud_all_channels.json
```

ice_cloud_all_channels.json 13.65 KiB


```
{
 "solar_zenith": 37.1,
 "solar_azimuth": 258.7,
 "viewing_zenith": 5.0,
 "viewing_azimuth": 70.0,
 "day_of_year": 190,
 "day_of_year_description": "needed for solar irradiance scaling",
 "longitude": 14.118,
 "latitude": 52.208,
 "skin_temperature": 284.54520088,
 "horizontal_windspeed_at_10m": 7.37,
 "salinity": 0.0,
 "pressure": [
  202.76731597,
  219.47257877,
  237.40117436,
  256.47258073,
  276.68542352,
  298.07732275,
  320.73312408,
  344.61804026,
  369.78265096,
  396.44831337,
  424.57194697,
  454.19212153,
  485.52054838,
  518.57862233,
  553.40350353,
  590.2343628,
```


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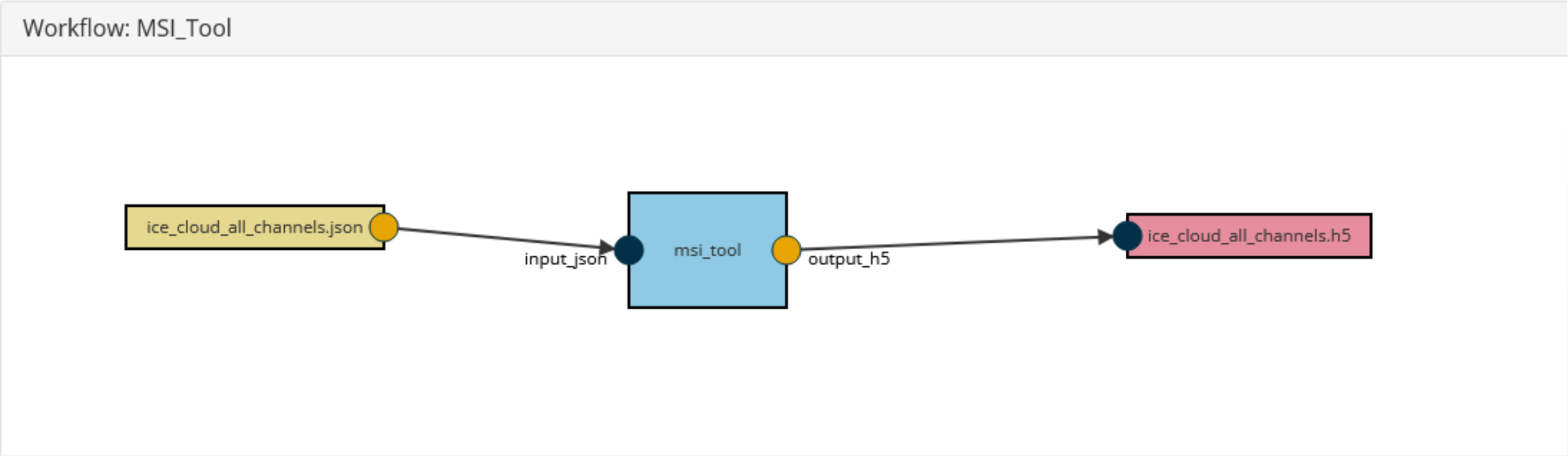
MSI Tool Example



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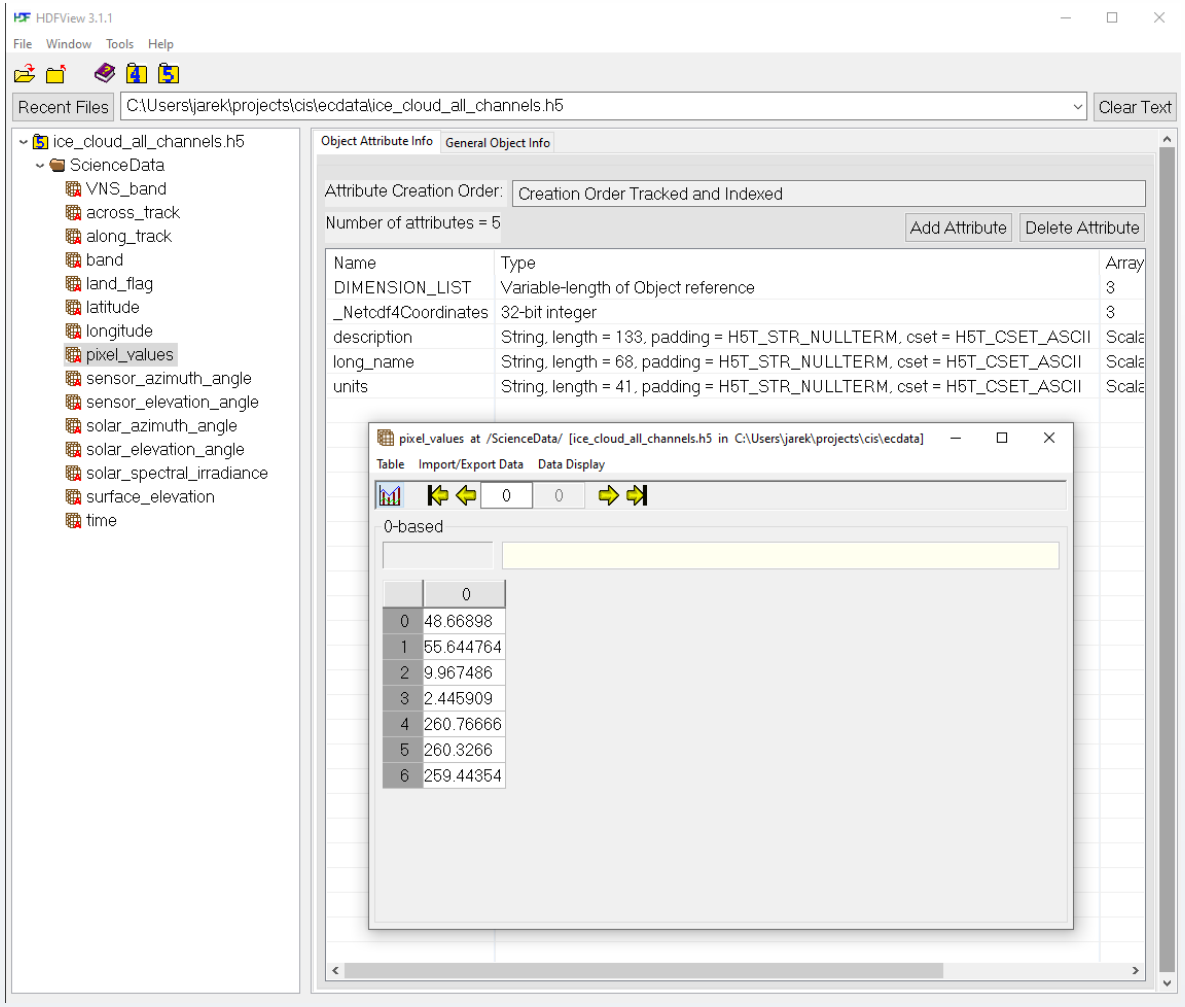
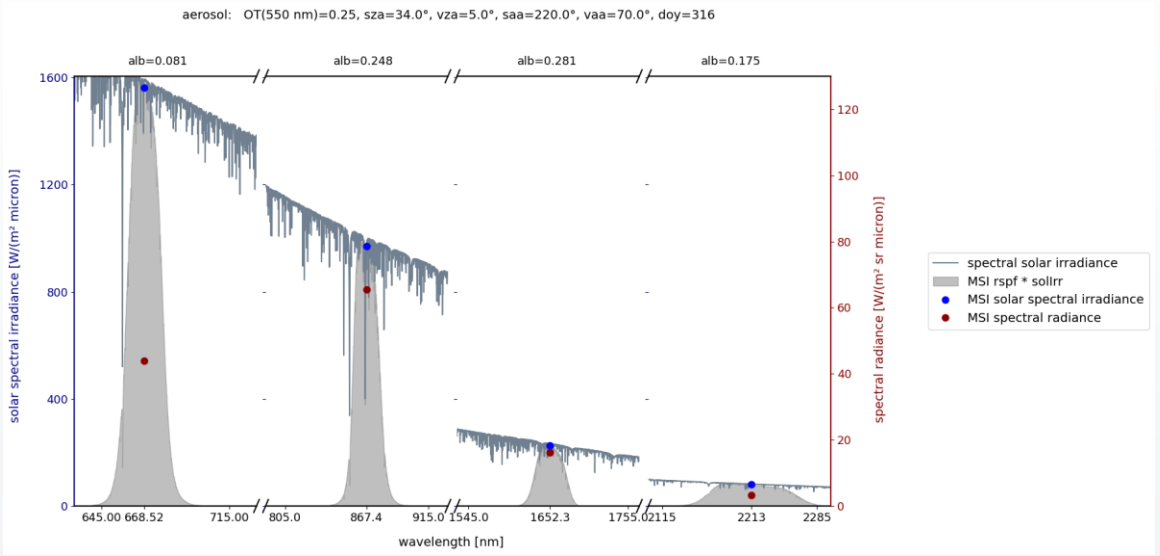
MSI Tool Example





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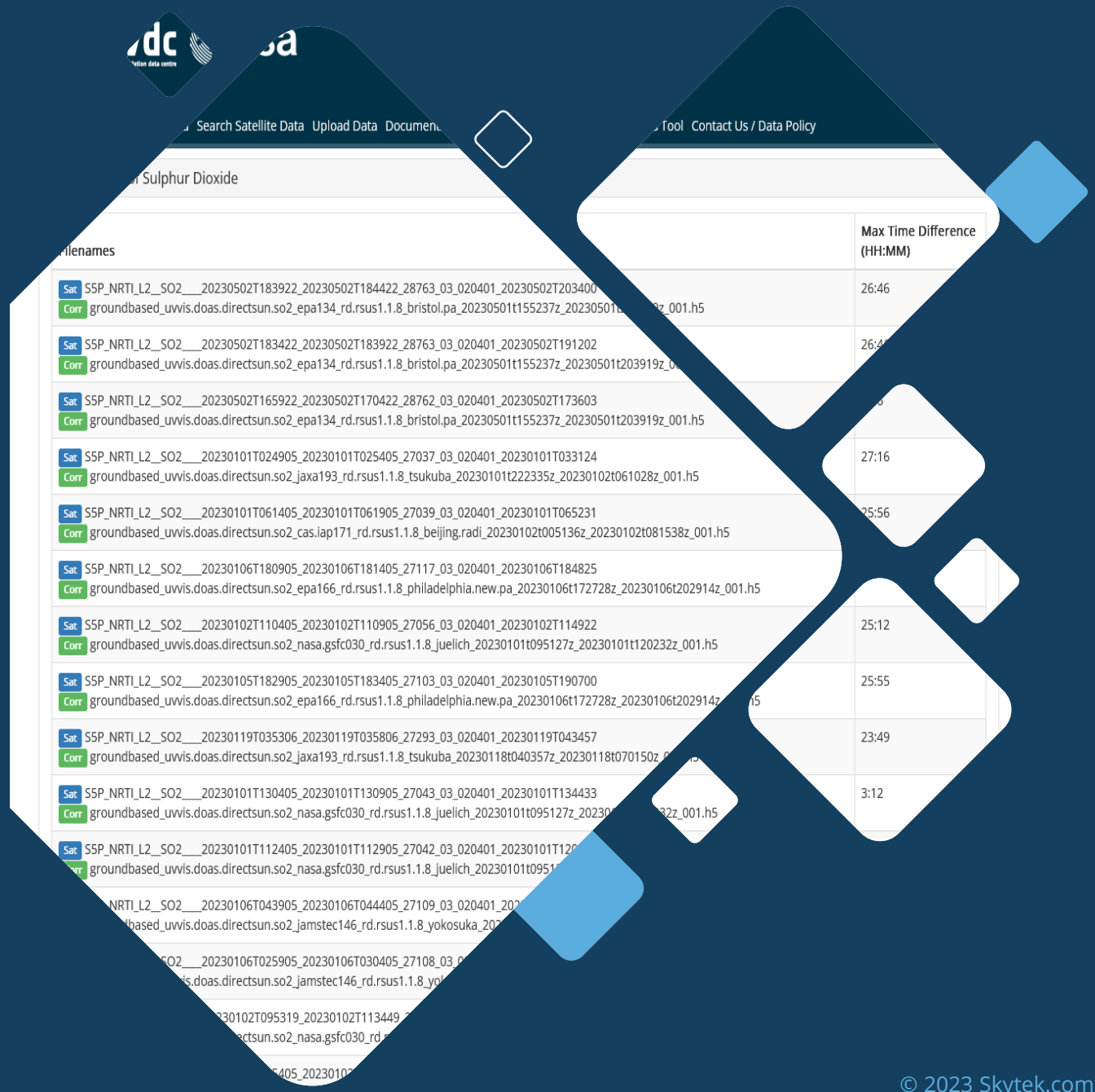

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SPACE TO INNOVATE

Collocation Database

evdc esa eo validation data centre
esa

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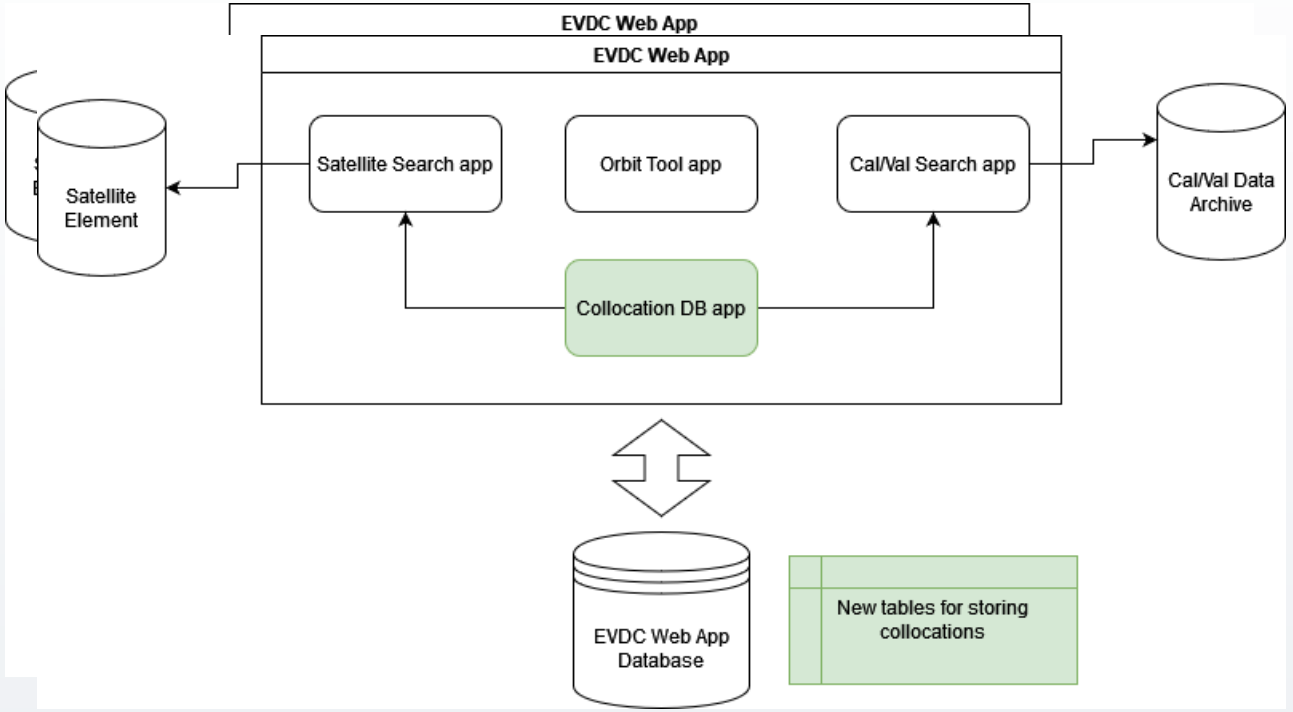
EVDC Collocation Database

The Goal:

- Automate the collection of broad collocations between satellite and correlative products
- Provide users with tools to interact with the archive of pre-collocated data
- Allow automated data deliveries based on custom (narrower) collocation criteria



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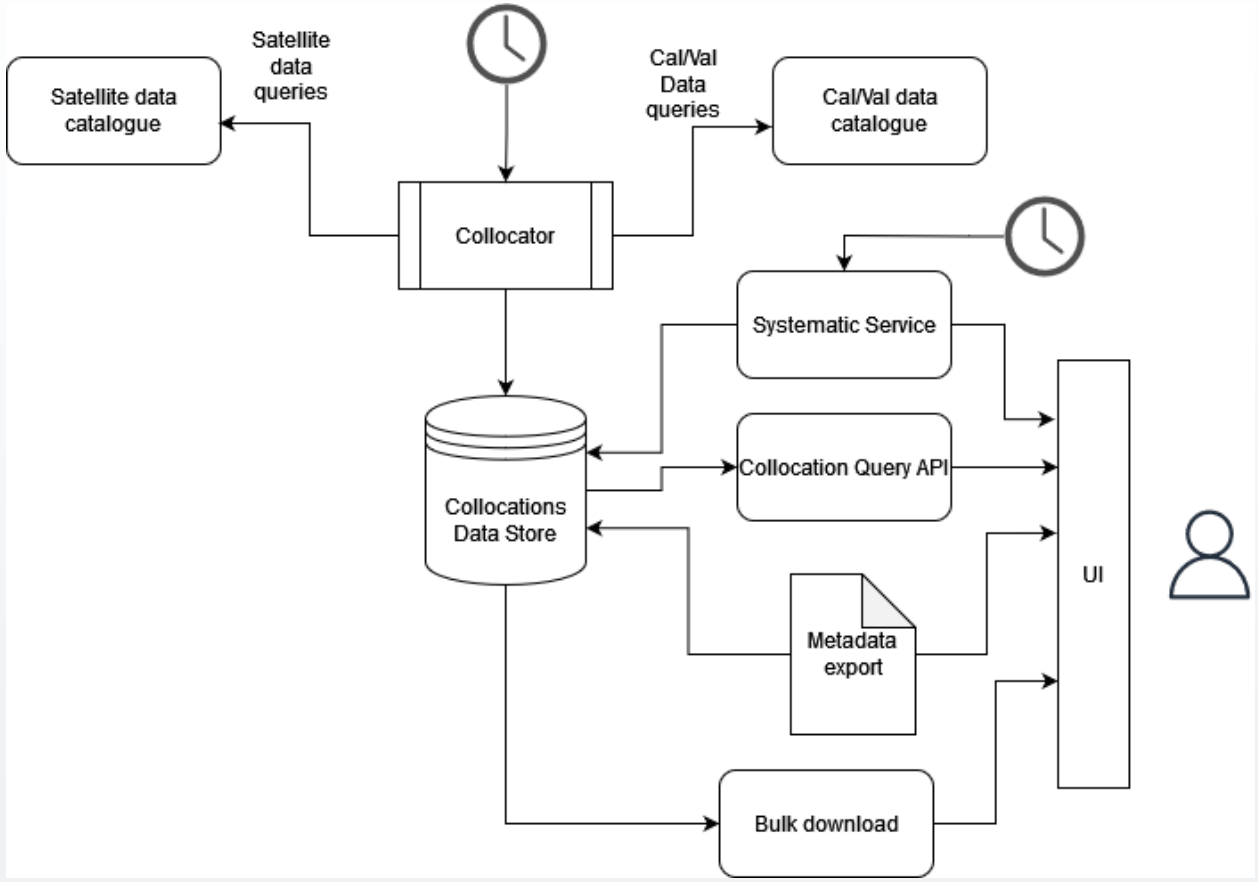
EVDC Collocation Database

Architecture

- Collocator as a scheduled service searching for new collocations daily
- Data store holding indexed metadata fields of both files (single entry represents 1:1 relation between sat and cal/val file)
- Query service for interacting with collocation data store



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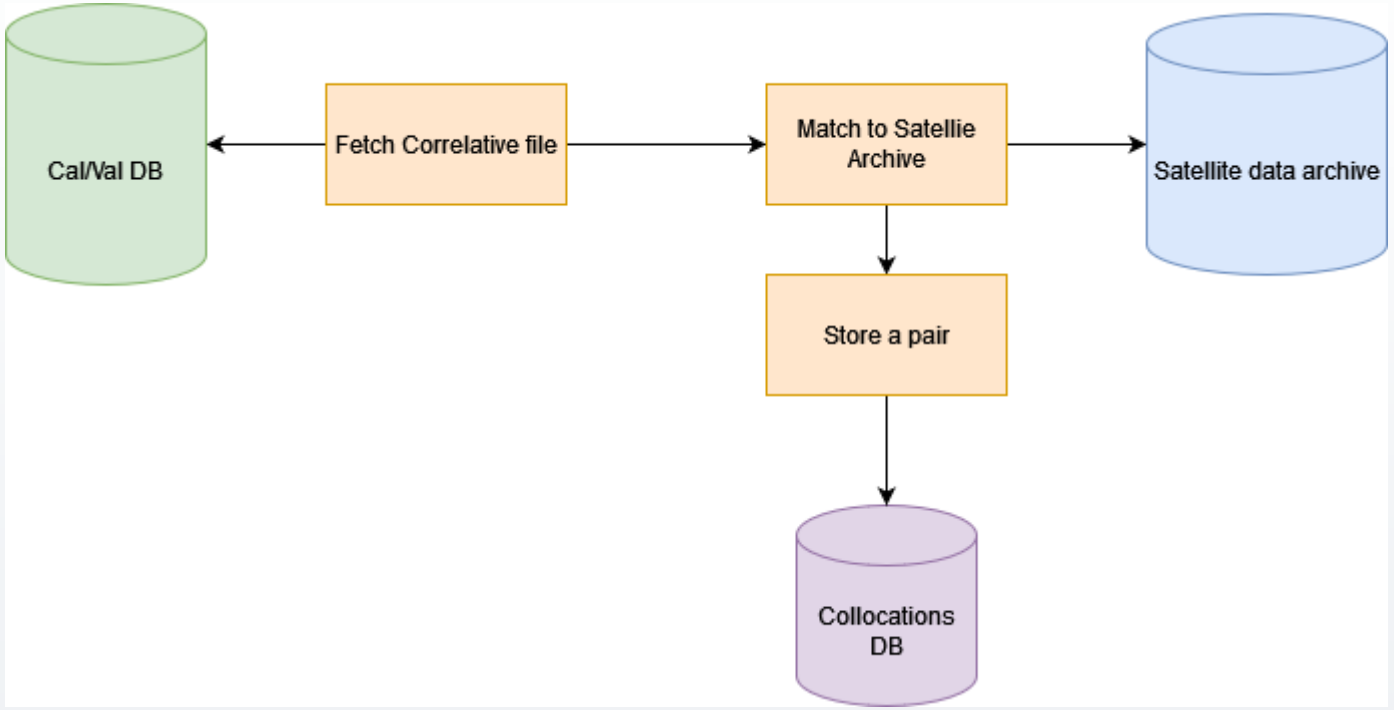
EVDC Collocation Database

Data Collection approach

- For each correlative file a single satellite product match is found Data store holding indexed metadata fields of both files (single entry represents 1:1 relation between sat and cal/val file)
- Reverse search then possible via the query service



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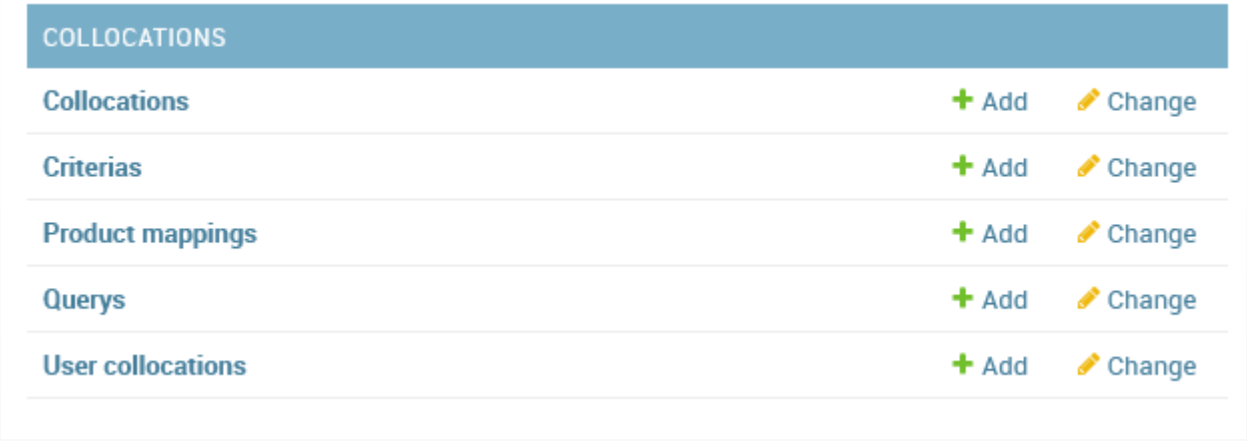
EVDC Collocation Database

Configuration. Variable mapping

- Manual config for referencing satellite product variables to correlative variables
- Common naming (preferred standard?)
- Possible to configure more detailed mapping details (units, scaling, conversion formulas



Home › Collocations › Product mappings

Select product mapping to change

ADD PRODUCT MAPPING +

Action: --------- Go 0 of 3 selected

	ID	CREATED	UPDATED	SATELLITE PARAMETER	CORRELATIVE PARAMETER	COMMON NAME	SP UNIT	SP SCALING	CP UNIT	CP SCALING	SP NODATA VALUE	CP NODATA VALUE	CONVERSION FORMULA
☐	3	June 25, 2023, 6:36 p.m.	June 25, 2023, 6:36 p.m.	S5P_*_L2__HCHO	H2CO.COLUMN	Formaldehyde	-	-	-	-	-	-	-
☐	2	June 25, 2023, 6:35 p.m.	June 25, 2023, 6:35 p.m.	S5P_*_L2__O3____	O3.COLUMN	Ozone	-	-	-	-	-	-	-
☐	1	June 25, 2023, 6:33 p.m.	June 25, 2023, 6:33 p.m.	S5P_*_L2__SO2___	SO2.COLUMN	Sulphur Dioxide	-	-	-	-	-	-	-

3 product mappings

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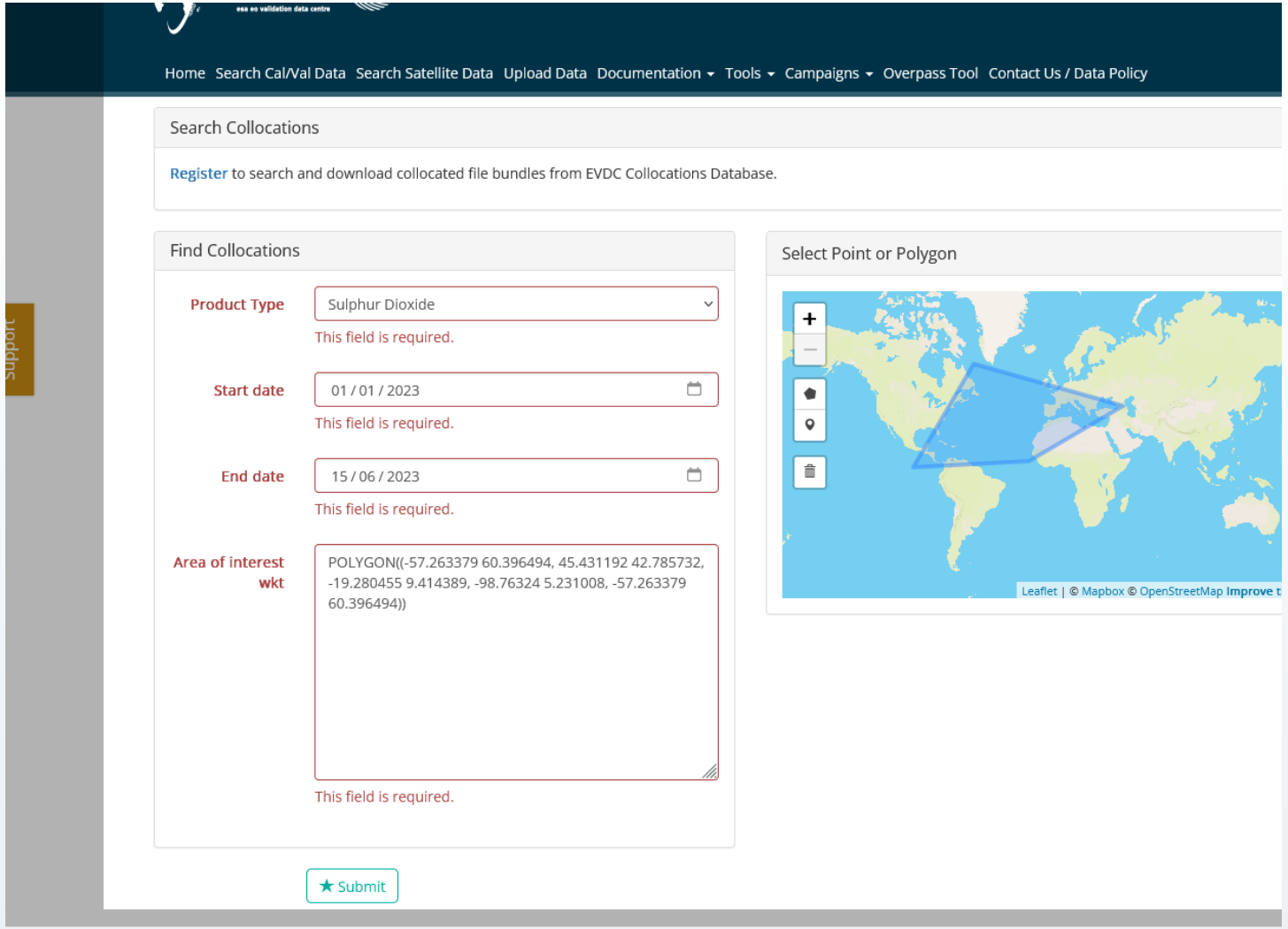
EVDC Collocation Database

Basic Query Form:

- Simple search based on spatiotemporal criteria and collocated variable selection
- Advanced search will also be provided (detail metadata fields, calculated statistics etc)



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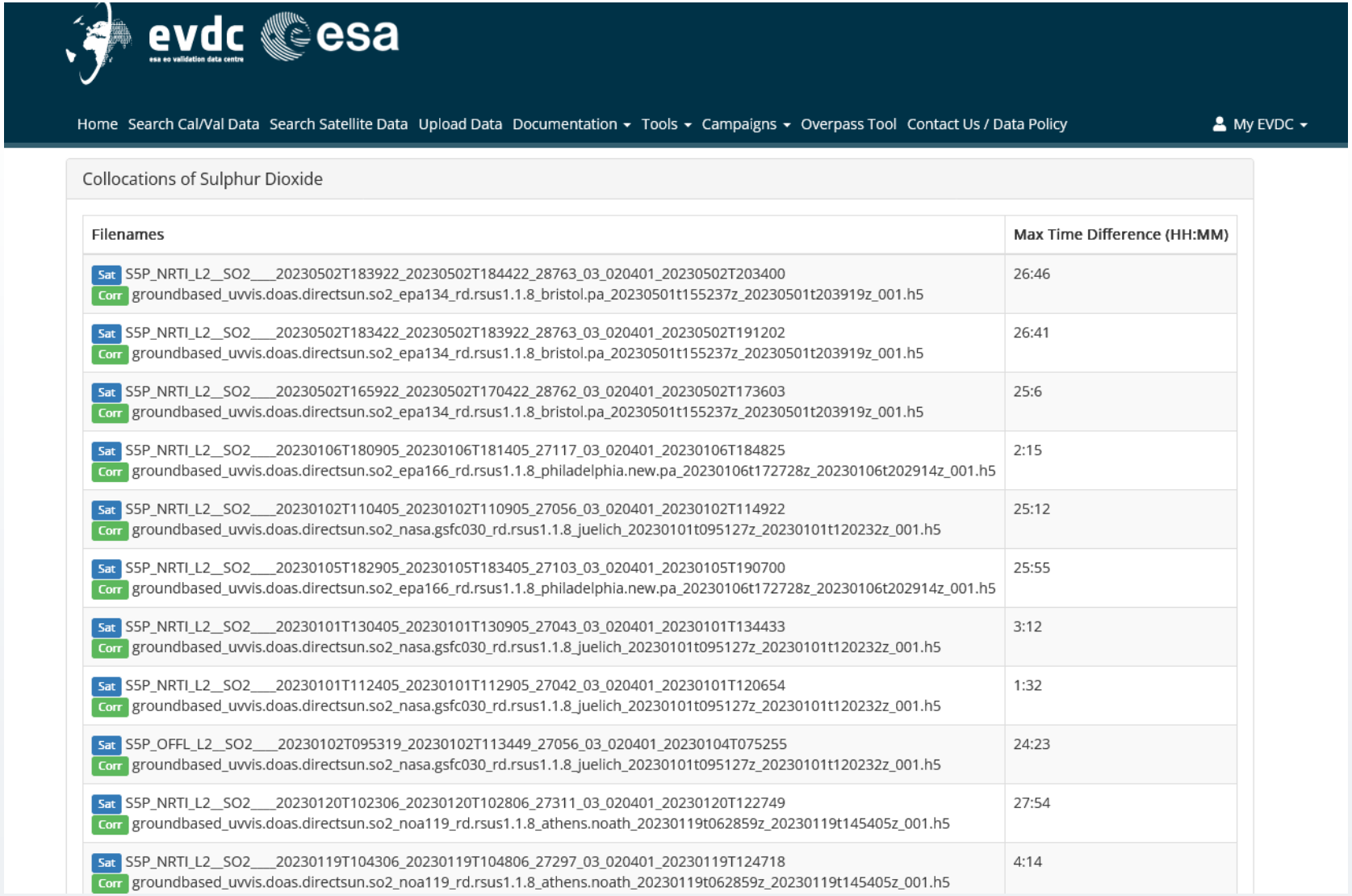
EVDC Collocation Database

Example search results



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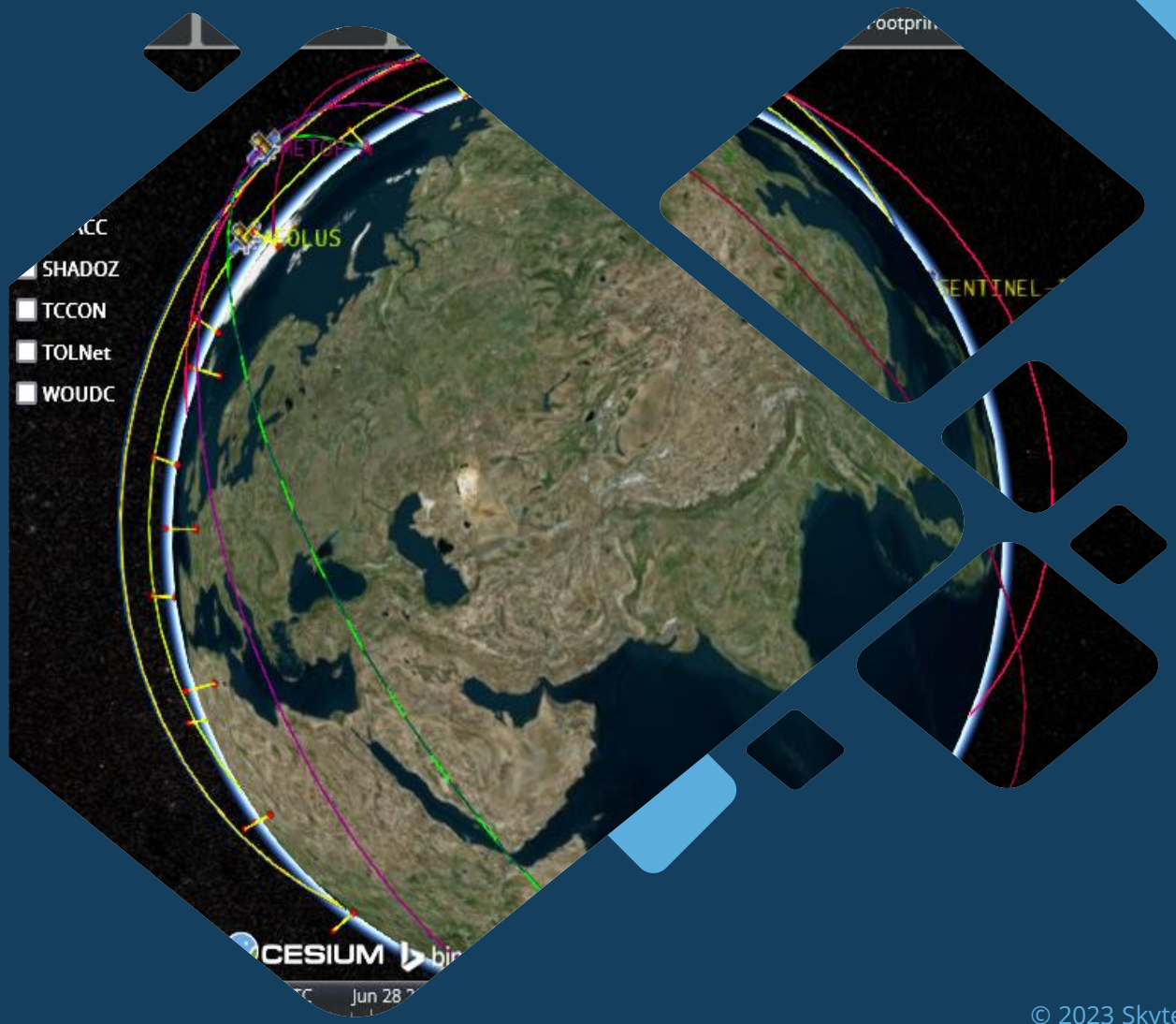

EVDC Orbit Tools

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esa

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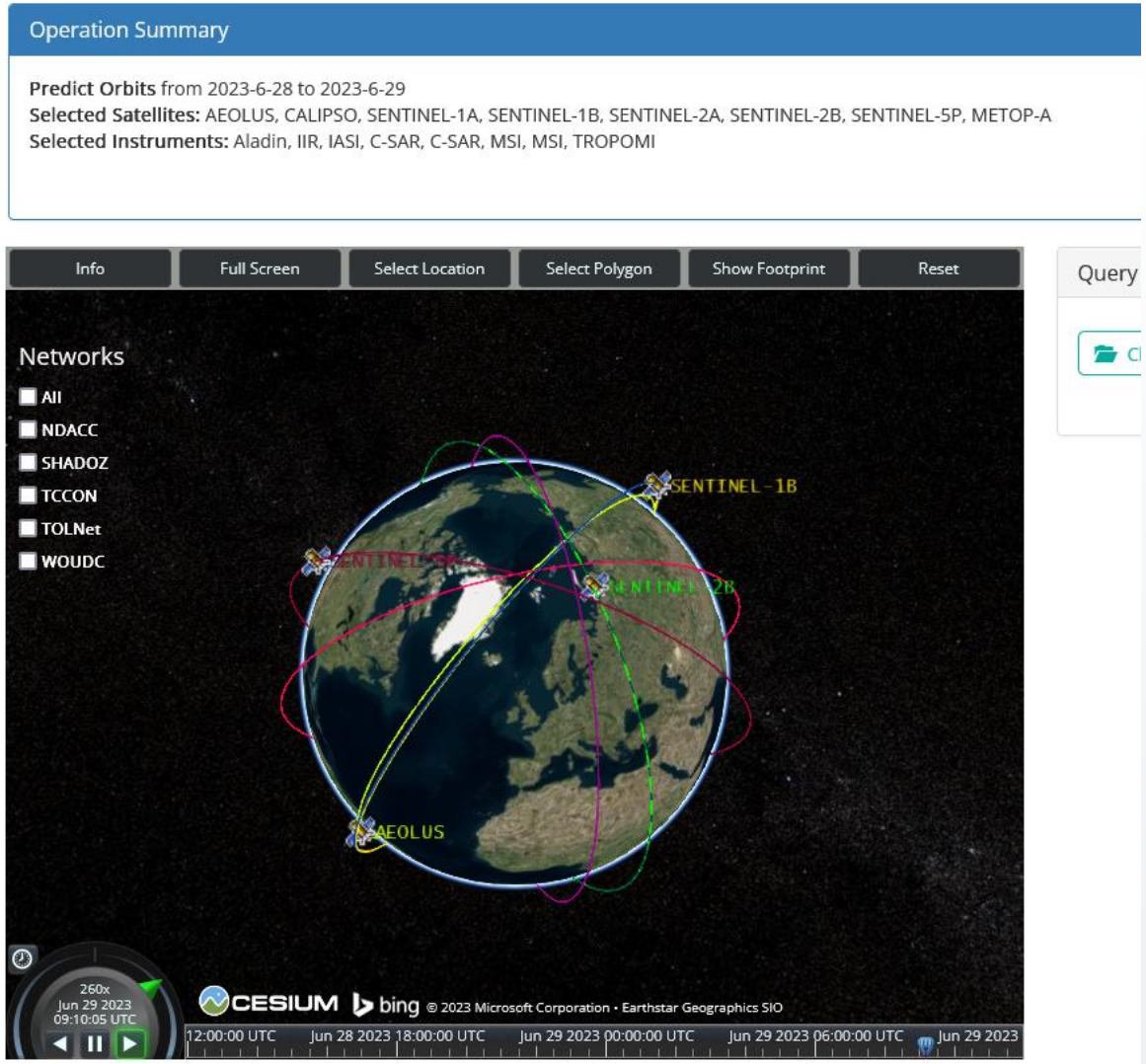
EVDC Orbit Tools

Functionalities:

- Orbit Prediction and Visualisation
- Finding Overpasses over AOIs
- Cal/Val Networks overlay and info
- Satellite footprint visualisation
- Overpass data download



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