BEeS 2026

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

PLOVDIV, BULGARIA 7-10 JULY 2026

ENVRI-Hub tools and VREs for researchers



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LifeWatch ERIC - Virtual Lab & Innovation Center (VLIC)

July 2026

LifeWatch ERIC

Universiteit van Amsterdam

ENVRI-Hub NEXT

eosc | EVERSE

NaaVRE Notebook as a Virtual Research Environment

LifeWatch: an infrastructure for biodiversity and ecosystem researchers

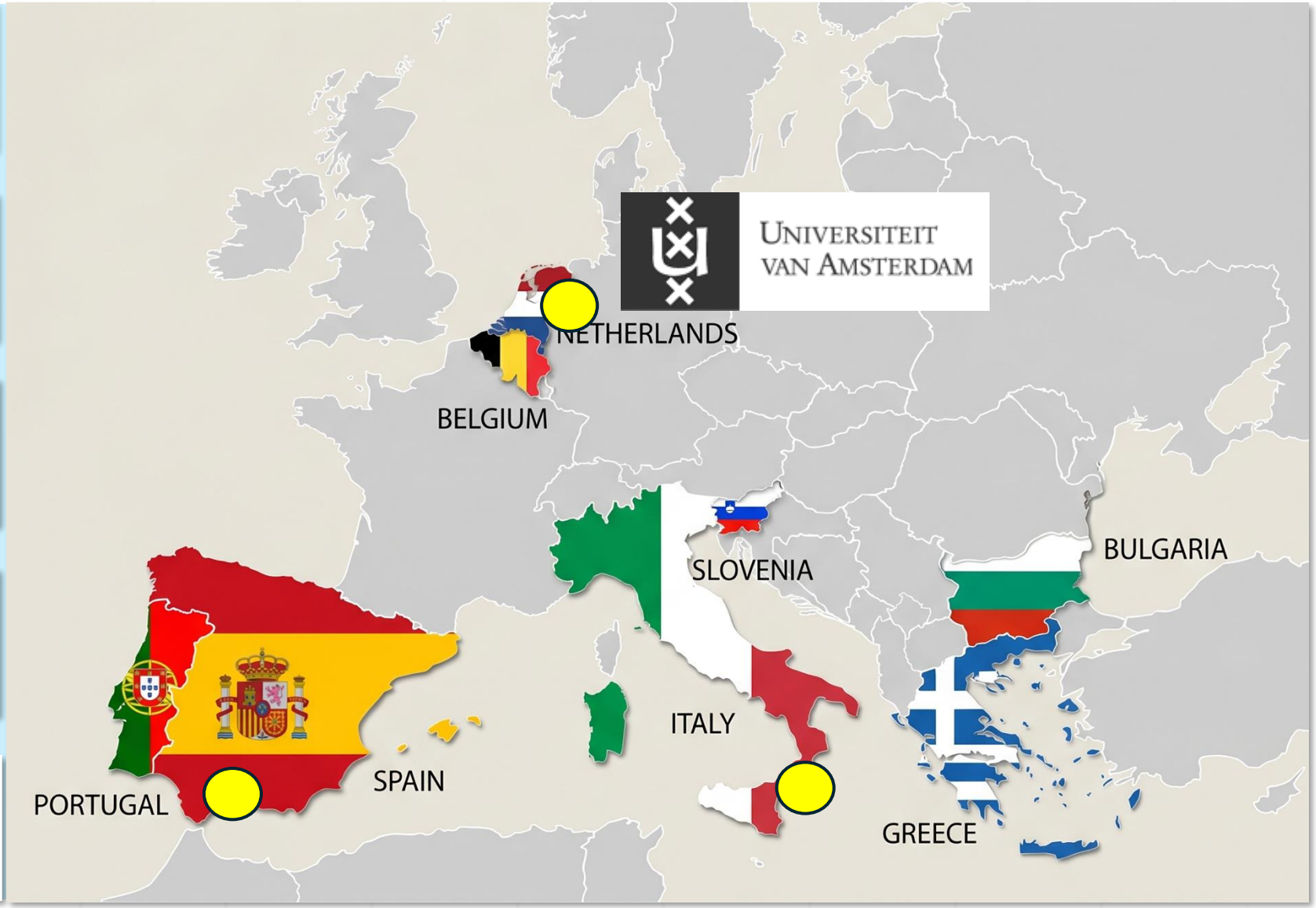
Data management
- Catalogue
- Search
- FAIRification

Research software
- Models
- Workflow management
- Virtual research environment

Capacity
- Computing
- Storage
- Network

New research methods
- Digital Twins
- AI
- ...

Community
- Training
- Support



Three Training Sessions: From Data to Quality Software

1

ENVRI-Hub NEXT

ENVRI-HUB & Essential Climate Variables

- Discover environmental research infrastructures
- Access ECV data via the ENVRI-HUB catalogue

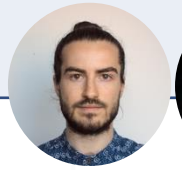
data feeds workflows

2

NaaVRE Notebook as a Virtual Research Environment

Workflow Co-development in a VRE

- Build analysis workflows collaboratively
- Share notebooks and tools in a Virtual Research Environment



workflows are software

3

eosc EVERSE

Research Software Quality Model & Assessment

- Apply the RSQKit quality model
- Assess and improve the software behind your workflows

Common thread: **FAIR climate data** → discovered and analysed through **collaborative workflows** → sustained by **quality-assessed research software**

Expected learning outcomes

- **Become familiar with** ENVRI, the ENVRI-HUB, Virtual Research Environment, and Research software quality
- **Understand** the basic concepts of Virtual Research Environments and the workflow co-development methodology
- **Be able to use** ENVRI-HUB services and the NaaVRE platform to run and co-develop simple workflows, and to assess the quality of the research software

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ENVRI-Hub and Essential Climate Variable (ECV) workflow

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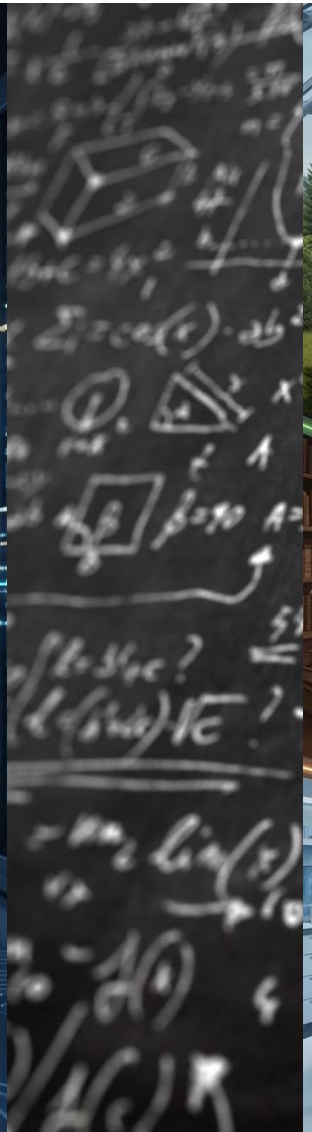
ENVRI-Hub NEXT

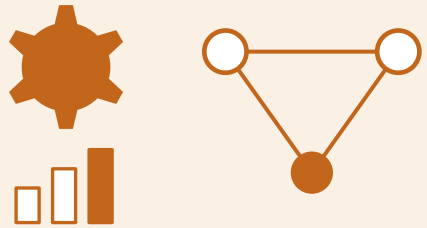
Computing technologies and scientific research



Infrastructures Supporting Scientific Research

Infrastructures for supporting scientific research

3



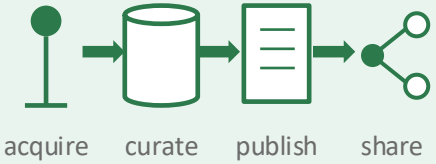
eScience tools (research Infrastructures)

Science-ready resources for analysis and collaboration

Tools, models & services · workflow composition & execution · virtual research environments (VREs)

e.g. **LifeWatch ERIC**

2

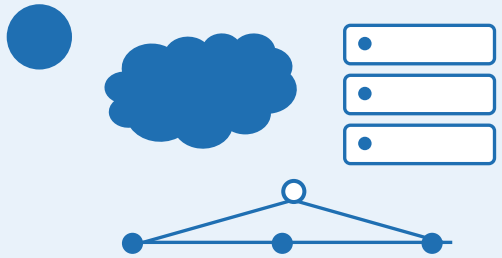


Data assets (data/research infrastructures)

Managing the full research data lifecycle

Acquisition from sensors & observatories · curation & quality control · publishing & sharing (FAIR)

e.g. **ICOS, eLTER, Euro-Argo, EPOS**



ICT capacity (e-Infrastructures)

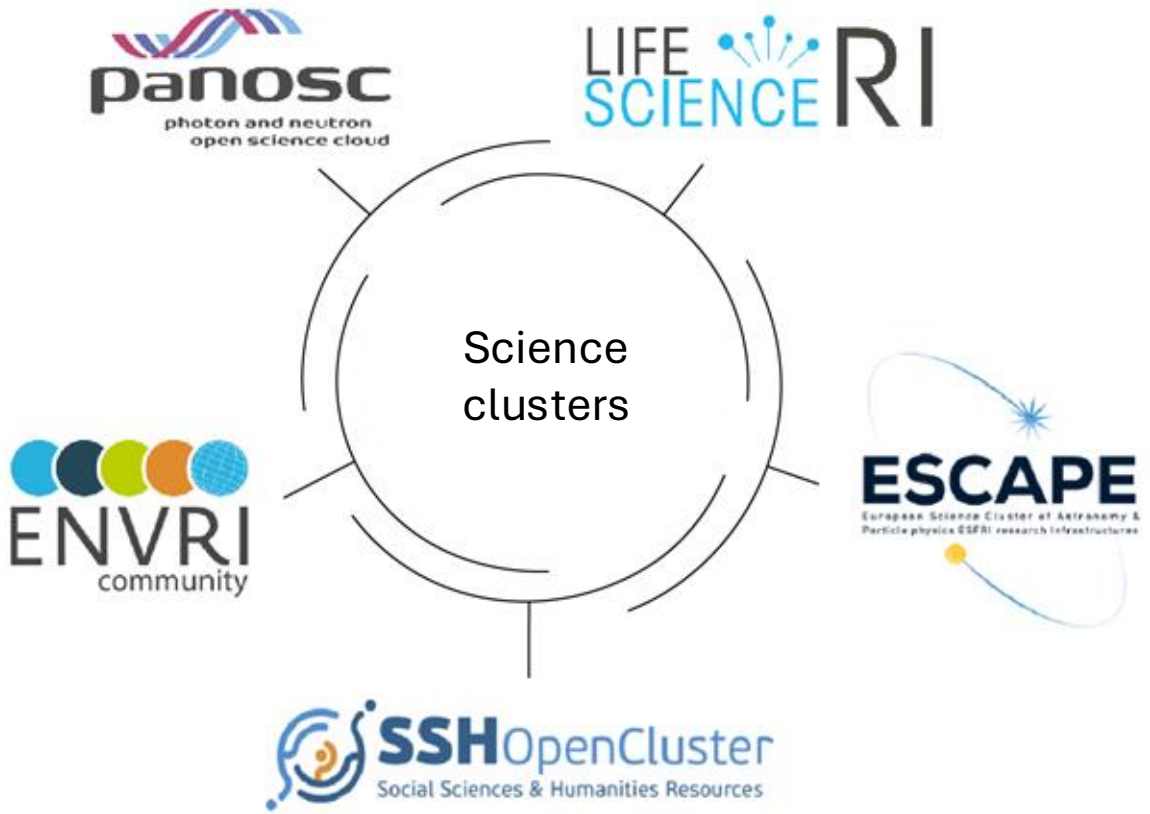
Generic computing, storage and networking capacity

Cloud, HTC & HPC computing · scalable, federated storage · high-speed connectivity & AAI

e.g. **EGI, EUDAT, GÉANT**

Infrastructures in scientific communities

- LifeScience
- Social science and Humanties
- Astronomy & Particle physics
- High energy physics (Photon and Neutron)
- **Environmental and earth sciences**



Expected learning outcomes

- **Understand** the concepts of the ENVRI-HUB
- **Understand** how the ENVRI-HUB can support Essential Climate Variable workflows
- **Gain practical familiarity** with the ENVRI-HUB services

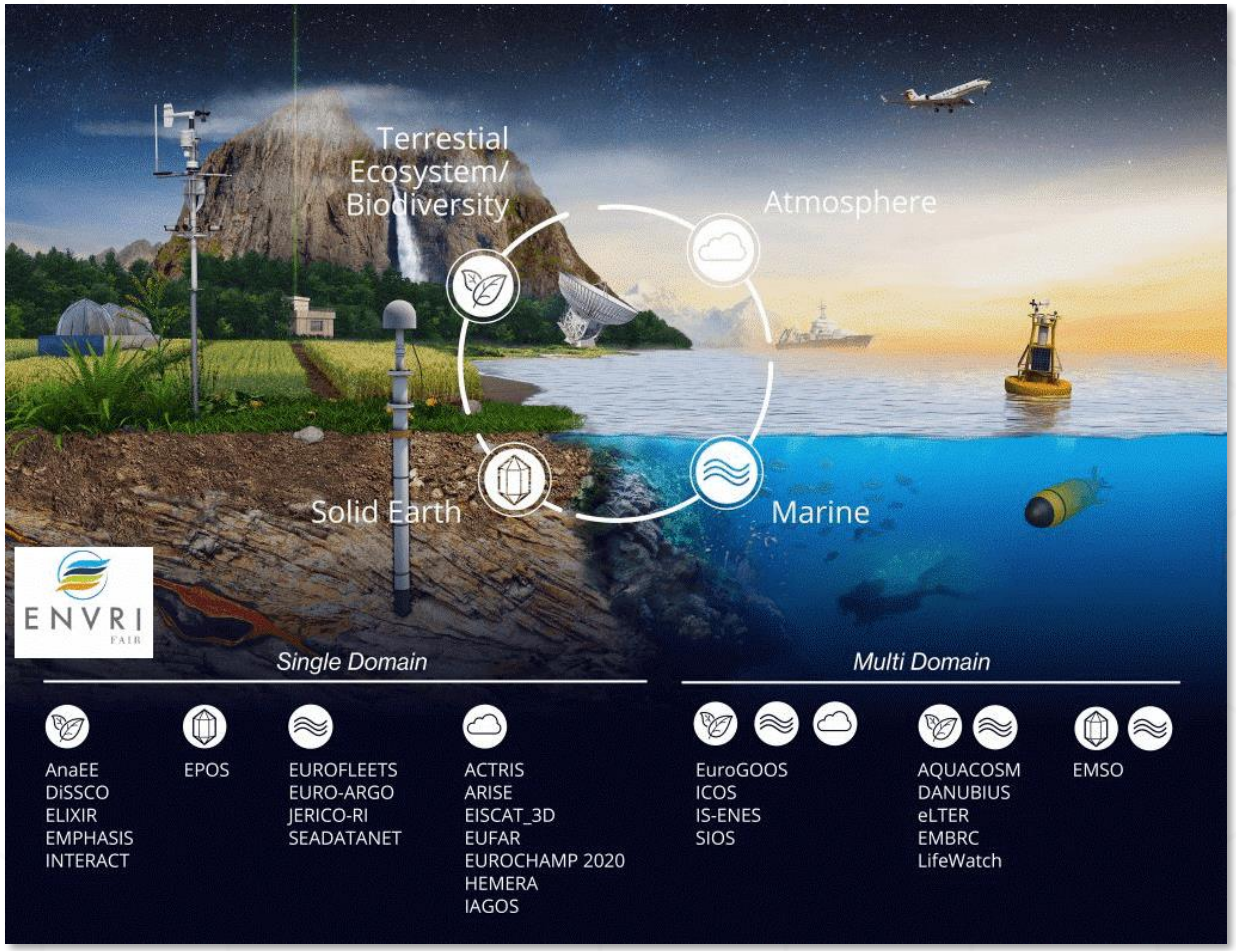
Outline

1. What is ENVRI and ENVRI-HUB?
2. Essential Climate Variables (ECV) and ENVRI-HUB
3. Jupyter notebook and Virtual Research Environment
4. Practice

1. What is ENVRI and ENVRI-HUB?

1. ENVRI:

- RIs in environmental and earth sciences



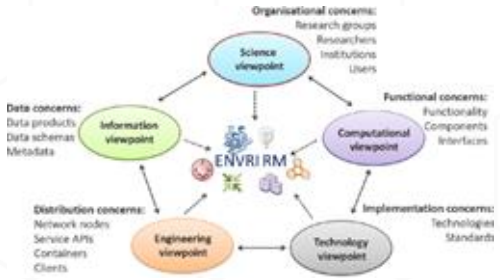
ENVRI together: 15 Years of collaborations

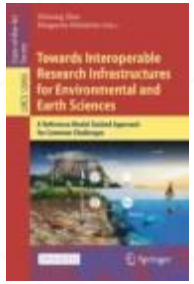
ENVRI
2011.11-2014.10

ENVRI-plus
2015.3-2019.2

ENVRI-FAIR
2019.3-2023.6

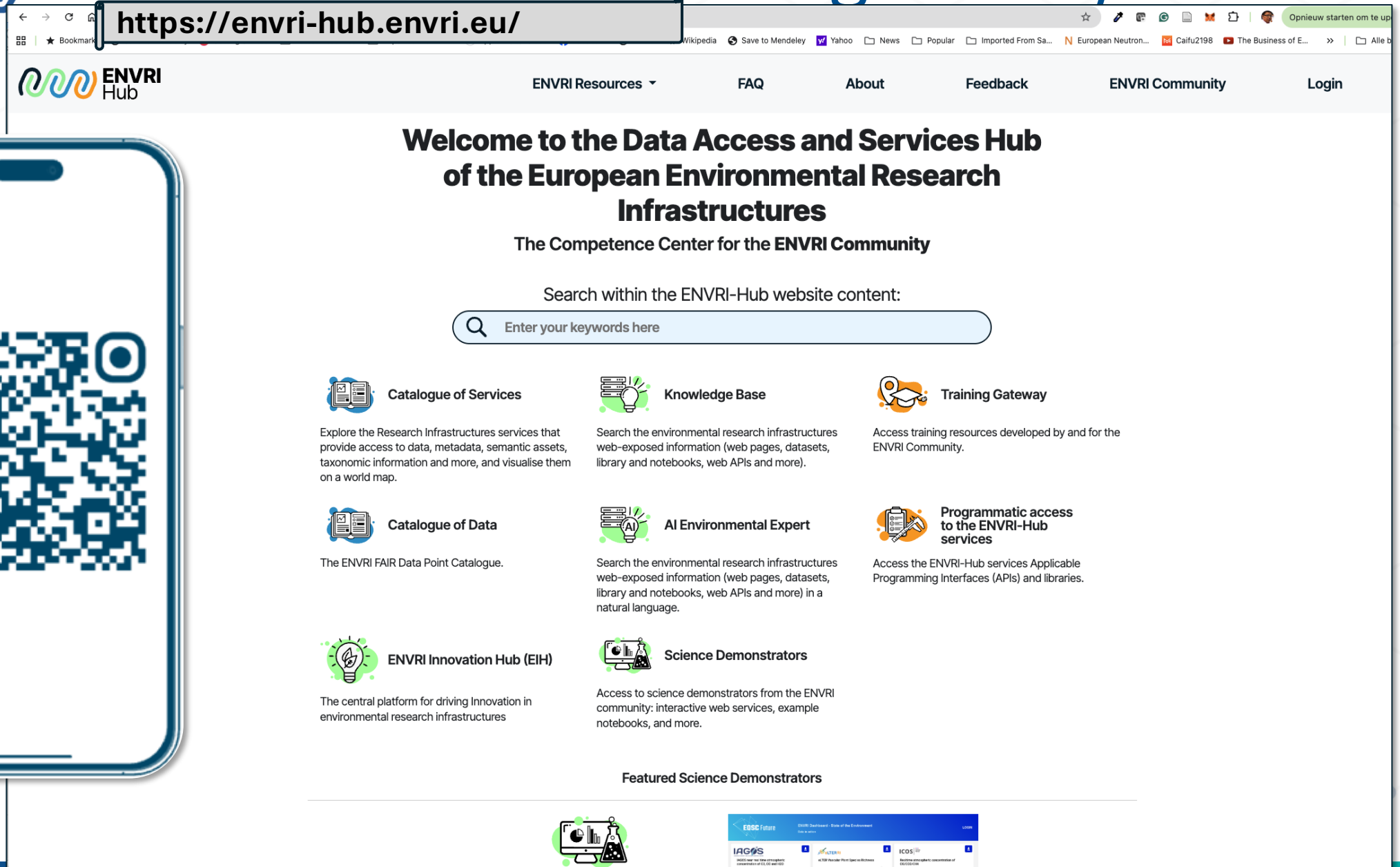
ENVRI-Hub NEXT
2024.2-2027.1



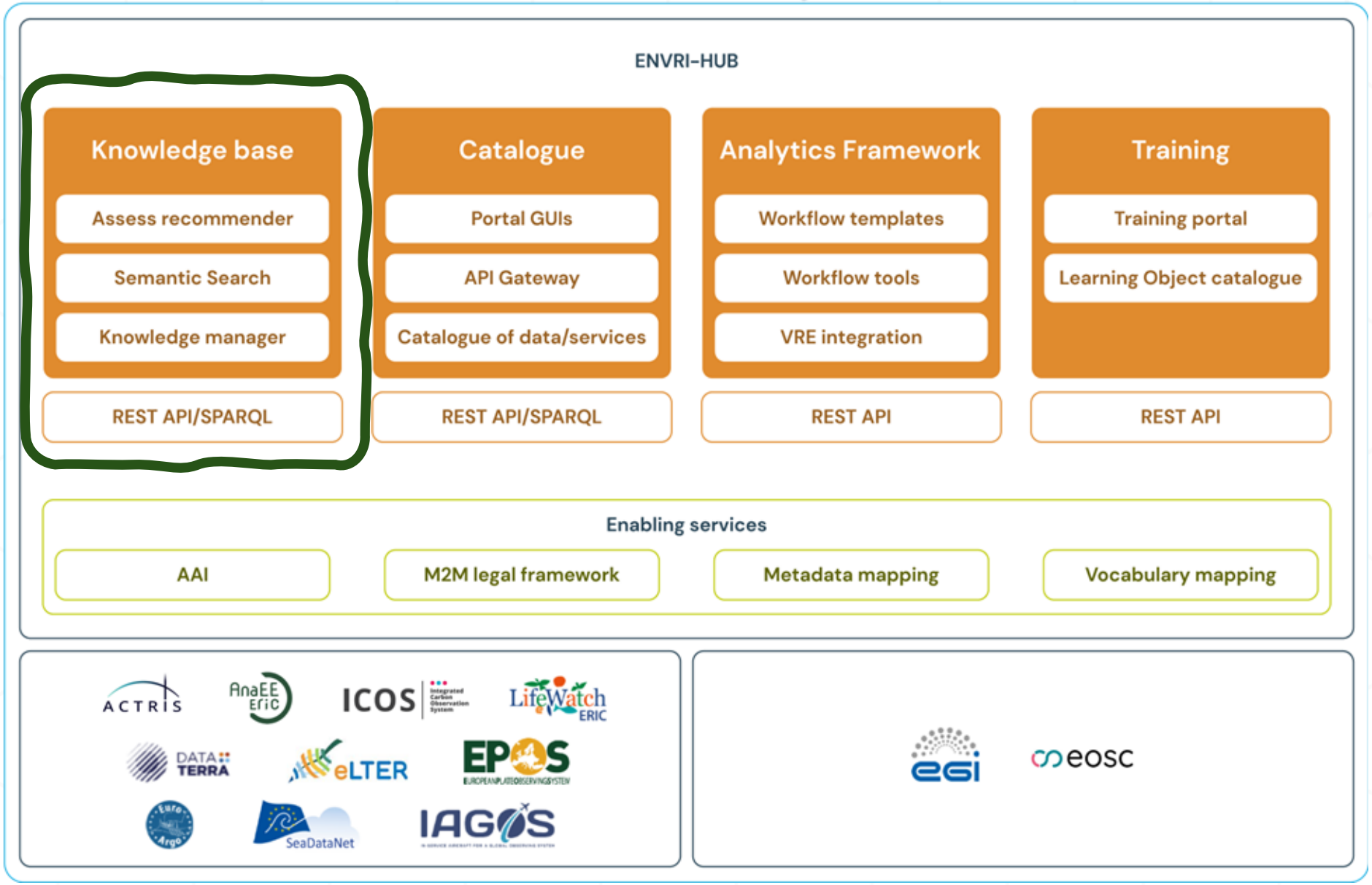


ENVRI-HUB : The gateway !

https://envri-hub.envri.eu/



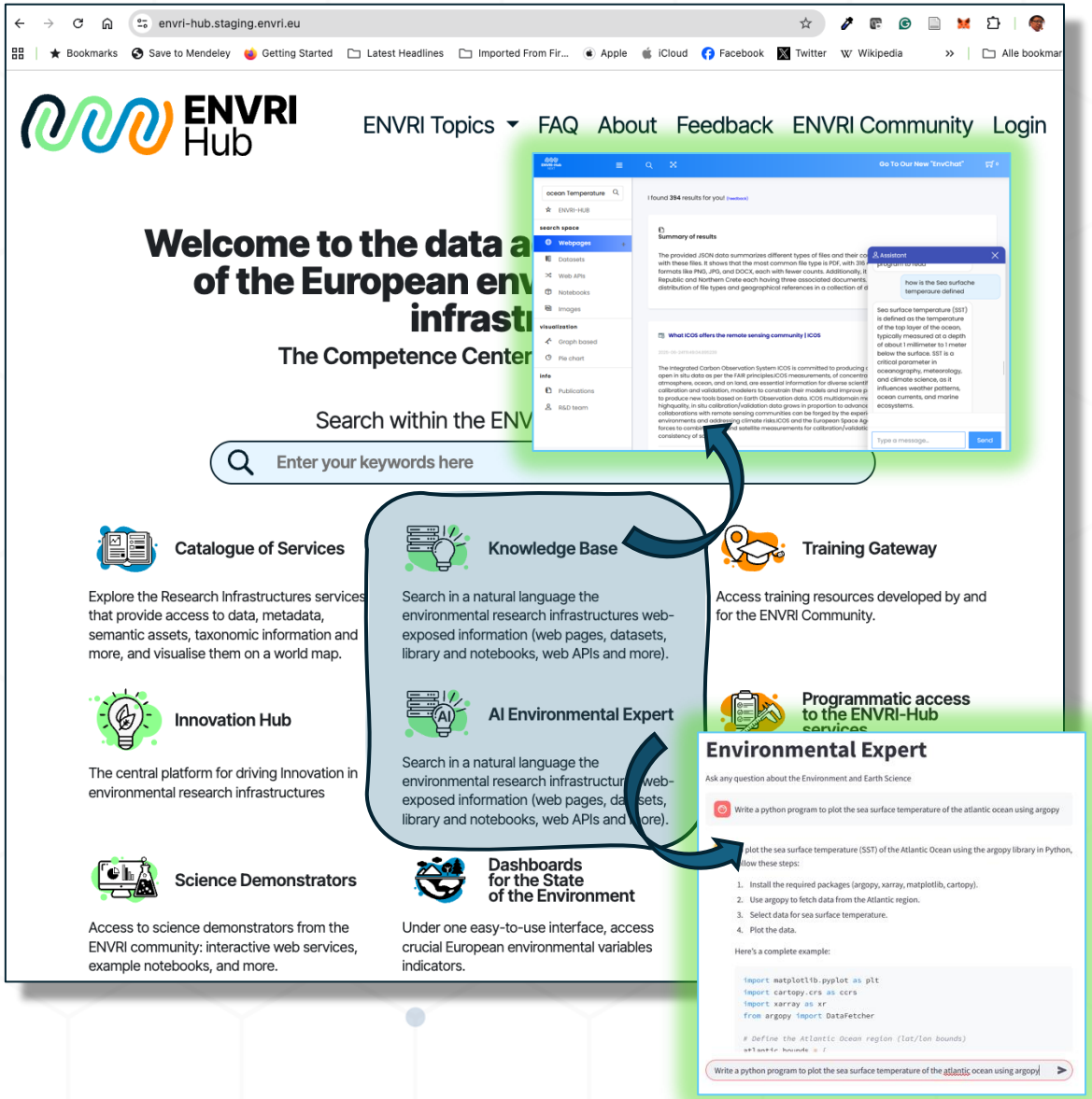
Architecture of ENVRI-HUB



ENVRI Knowledge Base

What is the Knowledge Base?

- The ENVRI Knowledge Base (ENVRI-KB) is a part of ENVRI-HUB.
- It improves upon the previous project, ENVRI-FAIR, by adopting a microservice-based system design for faster response times and scalability.
- It introduces the next generation of search technology for the Environmental RIs.
- ENVRI-KB Seamlessly integrates Generative AI into its core search functionalities.

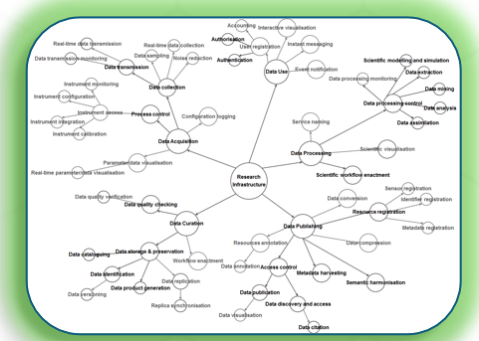


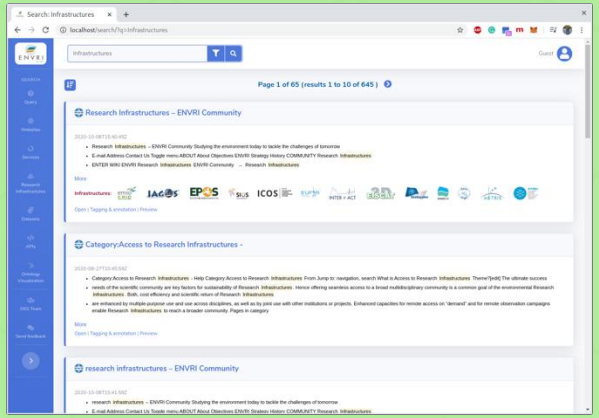
ENVRI Knowledge Base: A Short History

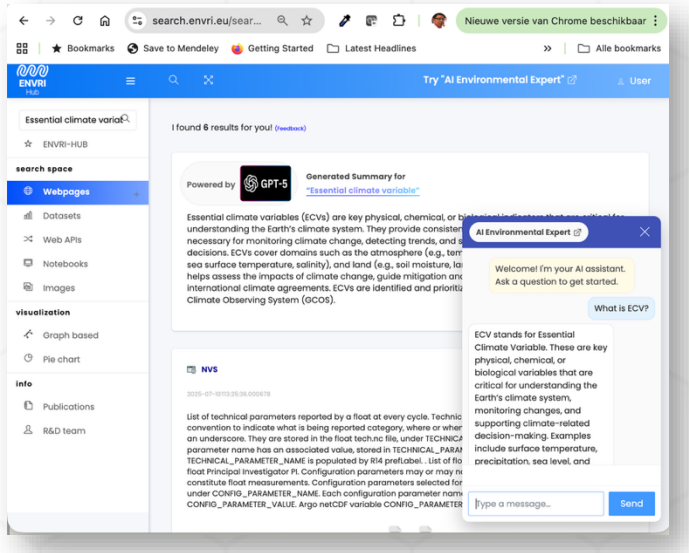
ENVRI-plus, 2015.3-2019.2

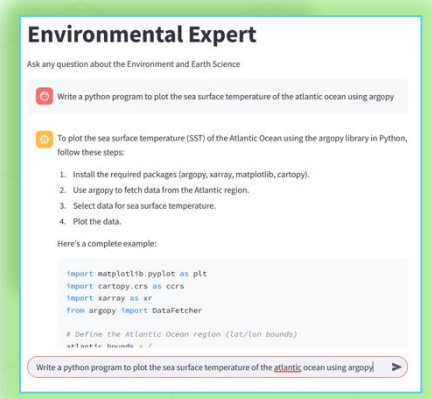
ENVRIFAIR 2019.3-2023.6

ENVRI-HUB next 2024.2-2027.1









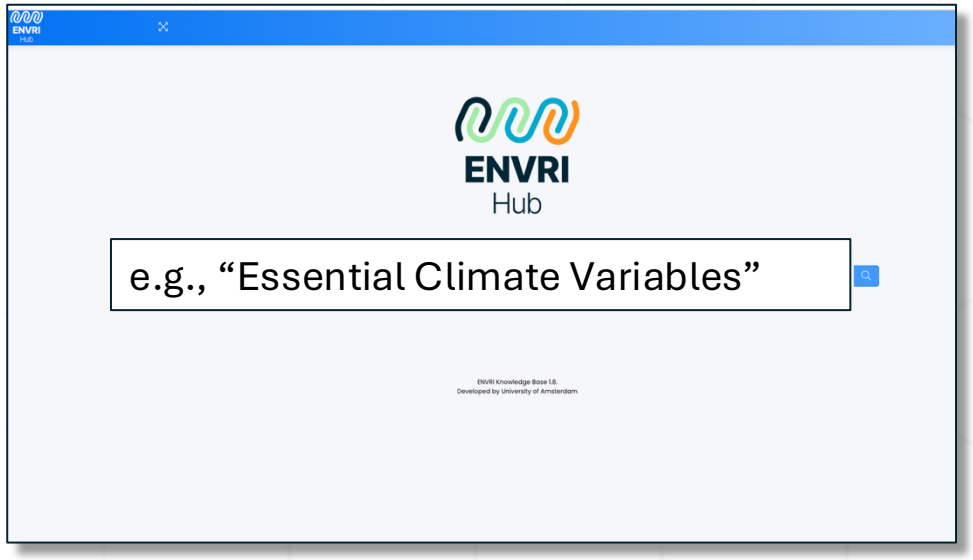
RI Developers: Data Management of RI Service Developers: FAIRification

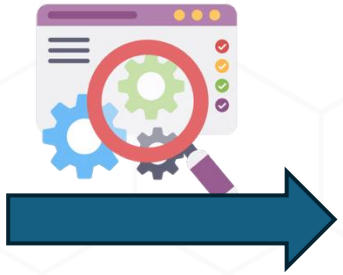
Users: RI (data, notebooks, documents) retrieval

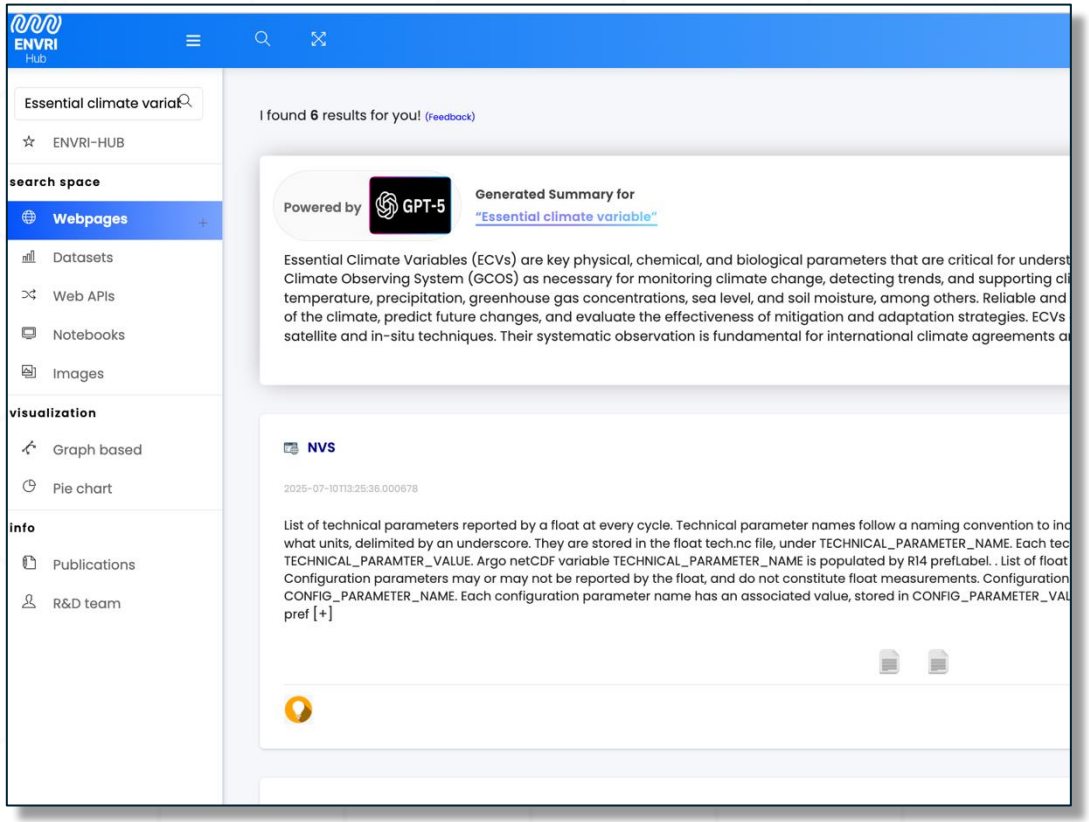
User: Dialogue enhanced Knowledge discovery

Knowledge Base Features: Free text search

ENVRI-KB - https://search.envri.eu

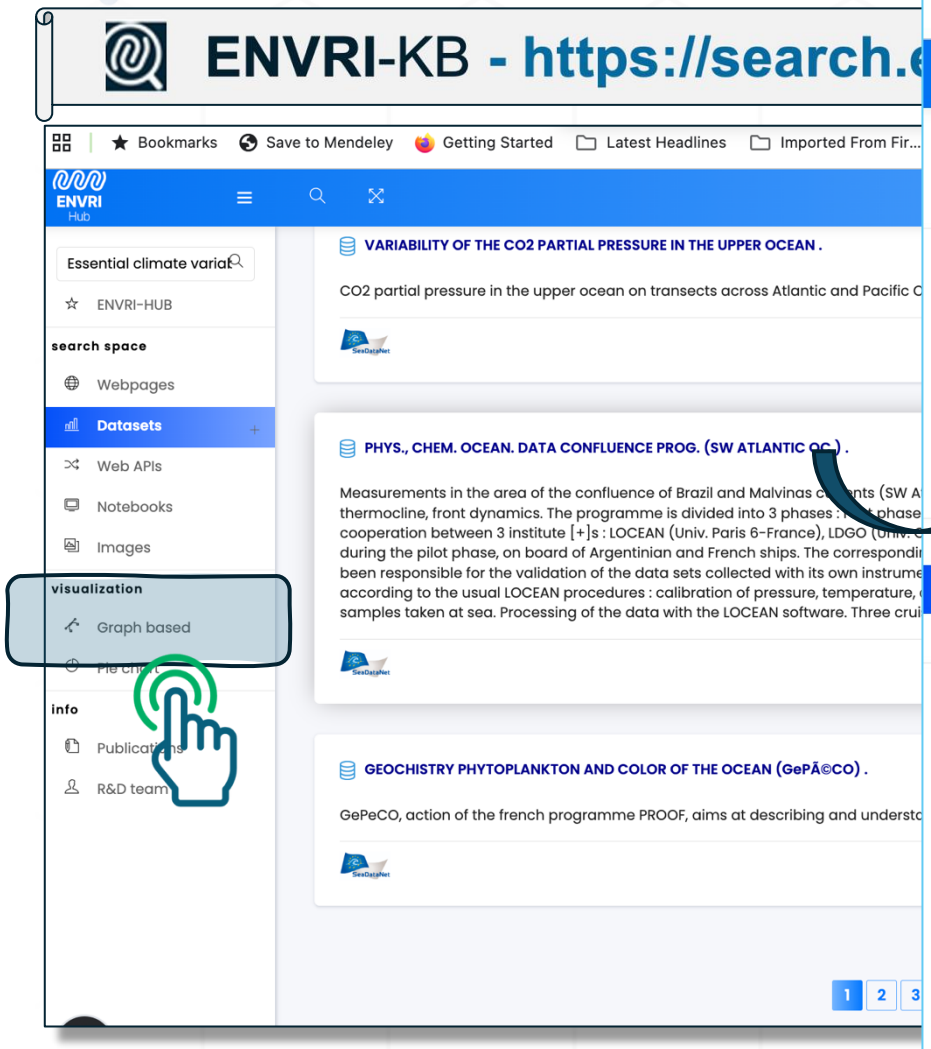


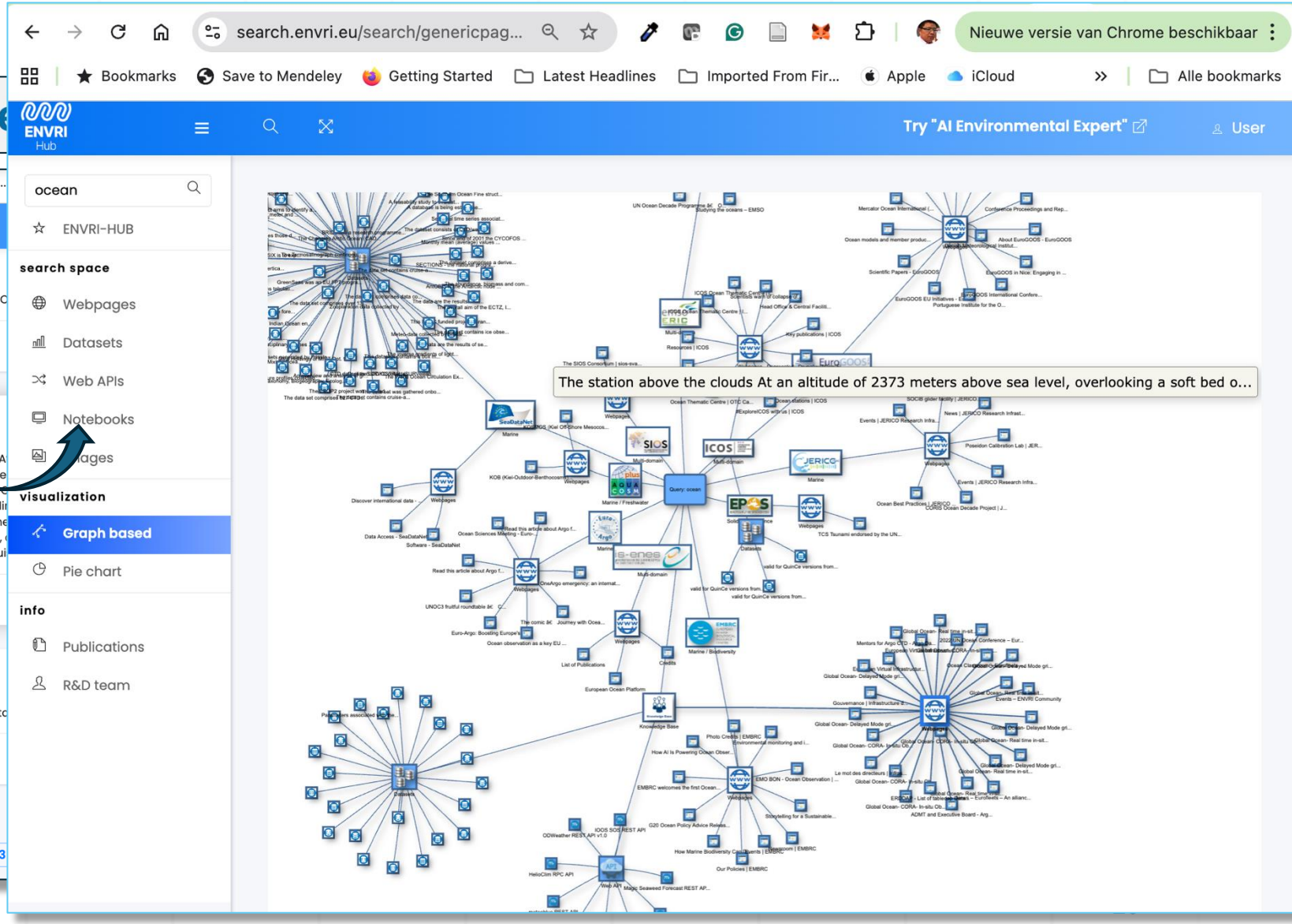




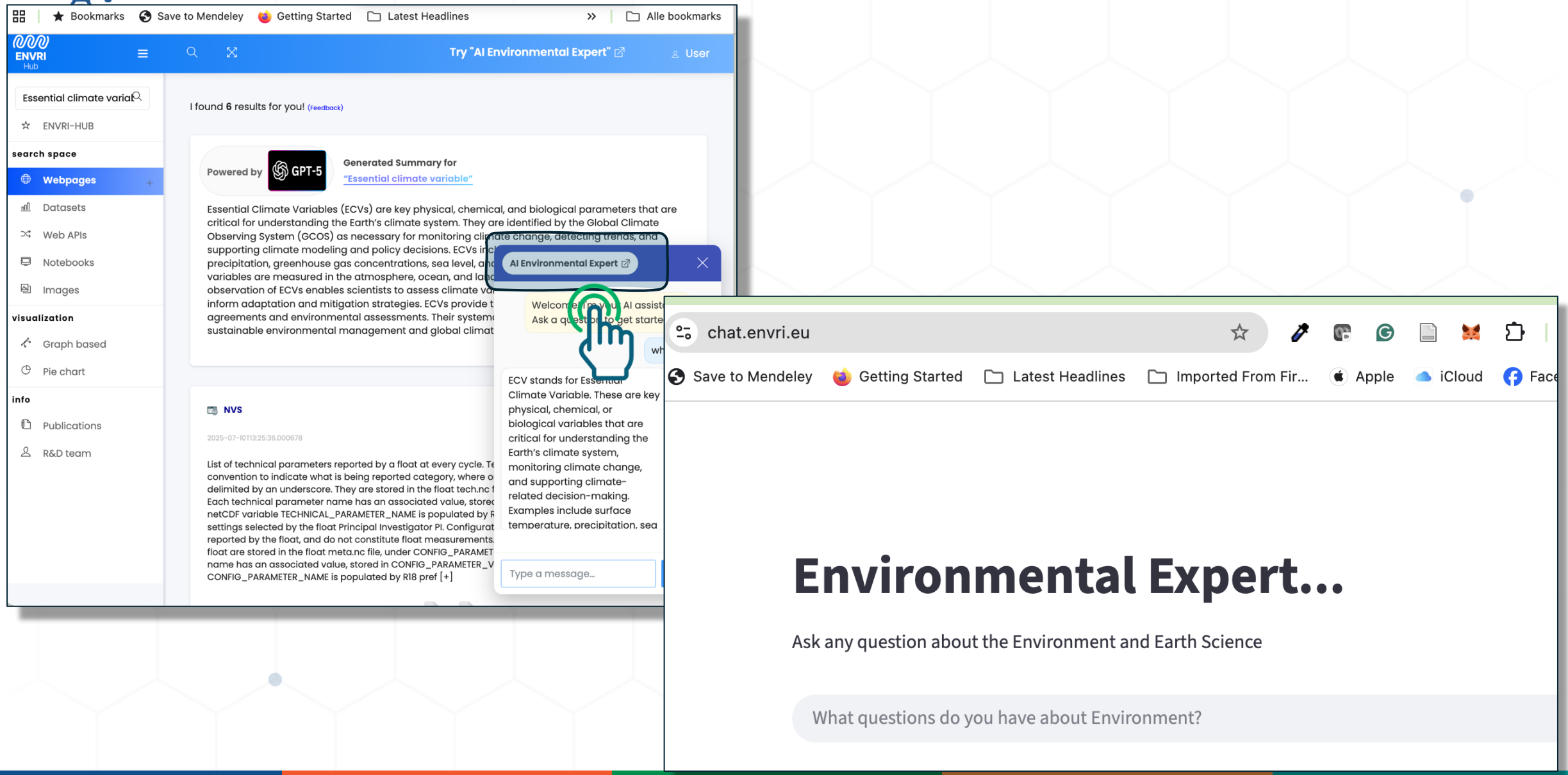
Knowledge Base Features: Free text search

Knowledge Base Features: Free text search

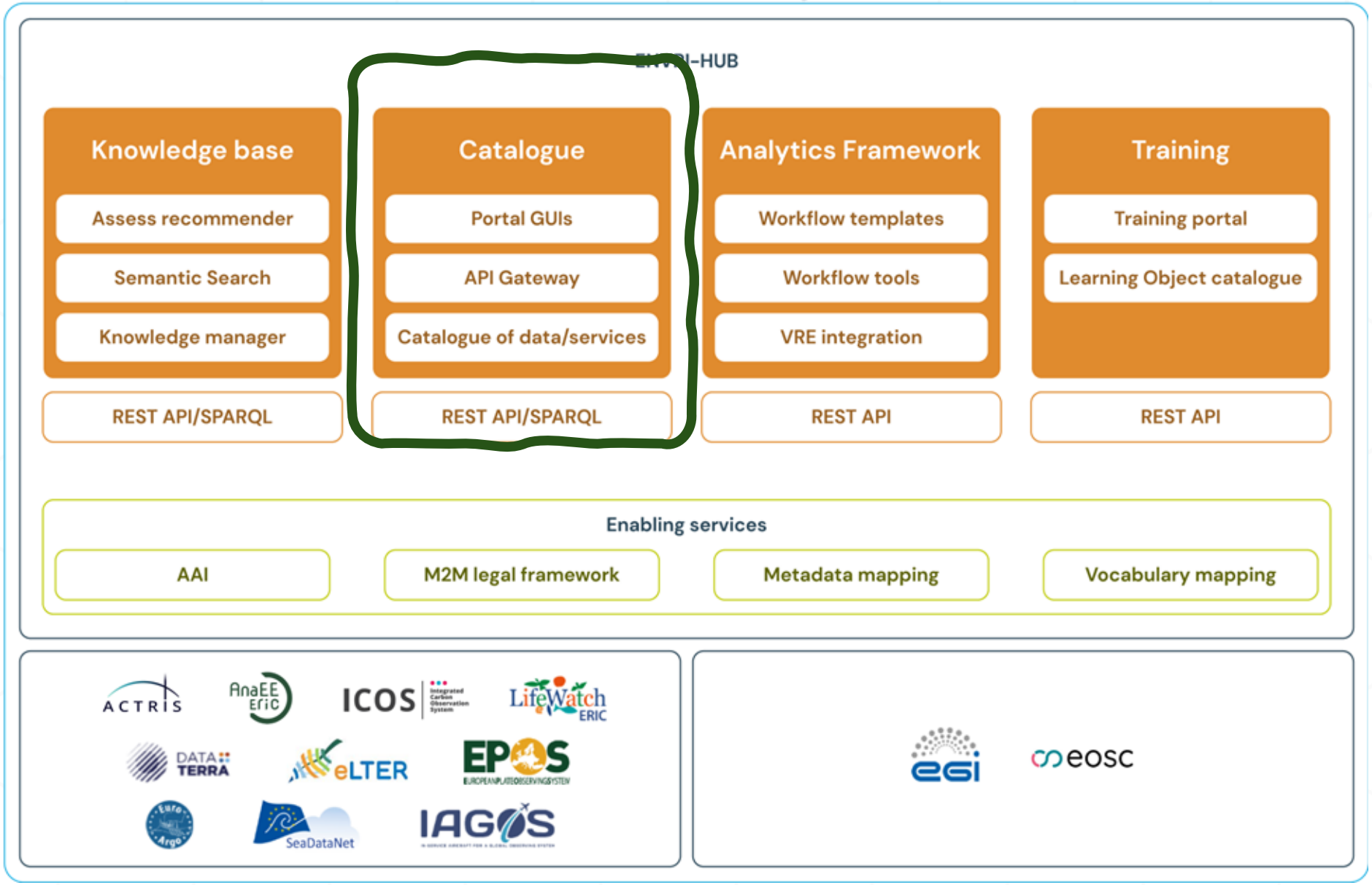




KB Features: Environmental Expert

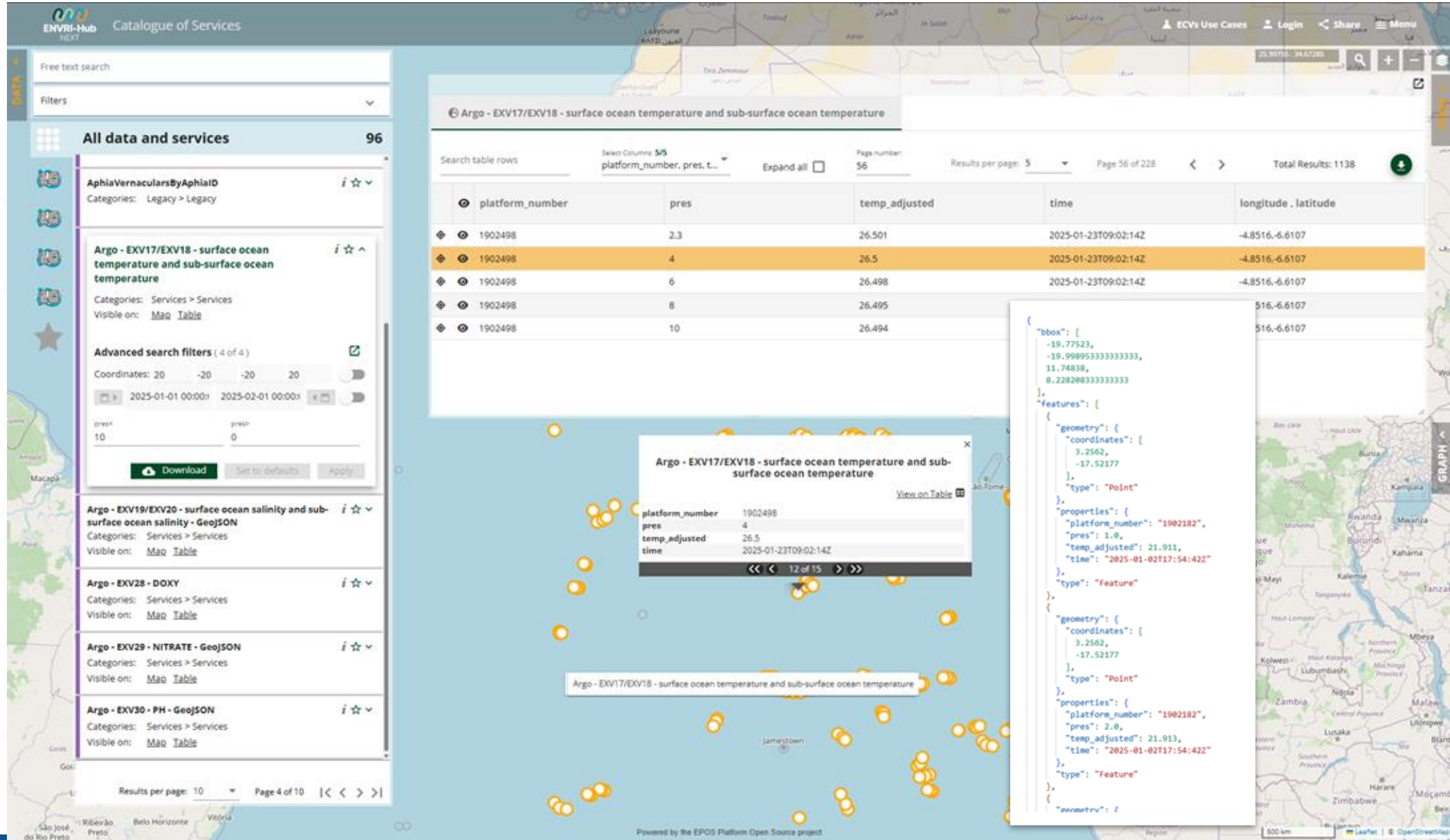


Architecture of ENVRI-HUB



Catalogue of services user interface

ENVRI Catalogue of Services



How does the ENVRI Service Catalogue work?

A common metadata schema enables one query across heterogeneous research infrastructure catalogues

Researchers & applications
one query, one common interface

e.g. "ocean & air temperature, 2010–2020, North Atlantic"
answered by all RIs at once

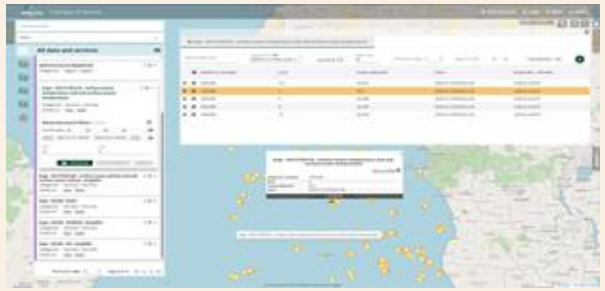
query in common terms

ENVRI Service Catalogue

single point of discovery & access

Unified query & access API search · filter · retrieve — across all federated RI catalogues

COMMON METADATA SCHEMA: variable · location · time · provider · access



queries ↓ mapped records ↑

native ⇄ common

native ⇄ common

native ⇄ common

ICOS catalogue

REST API

native metadata schema
gas species · station · sampling period

Euro-Argo catalogue

REST API

native metadata schema
float · sensor · cycle · profile depth

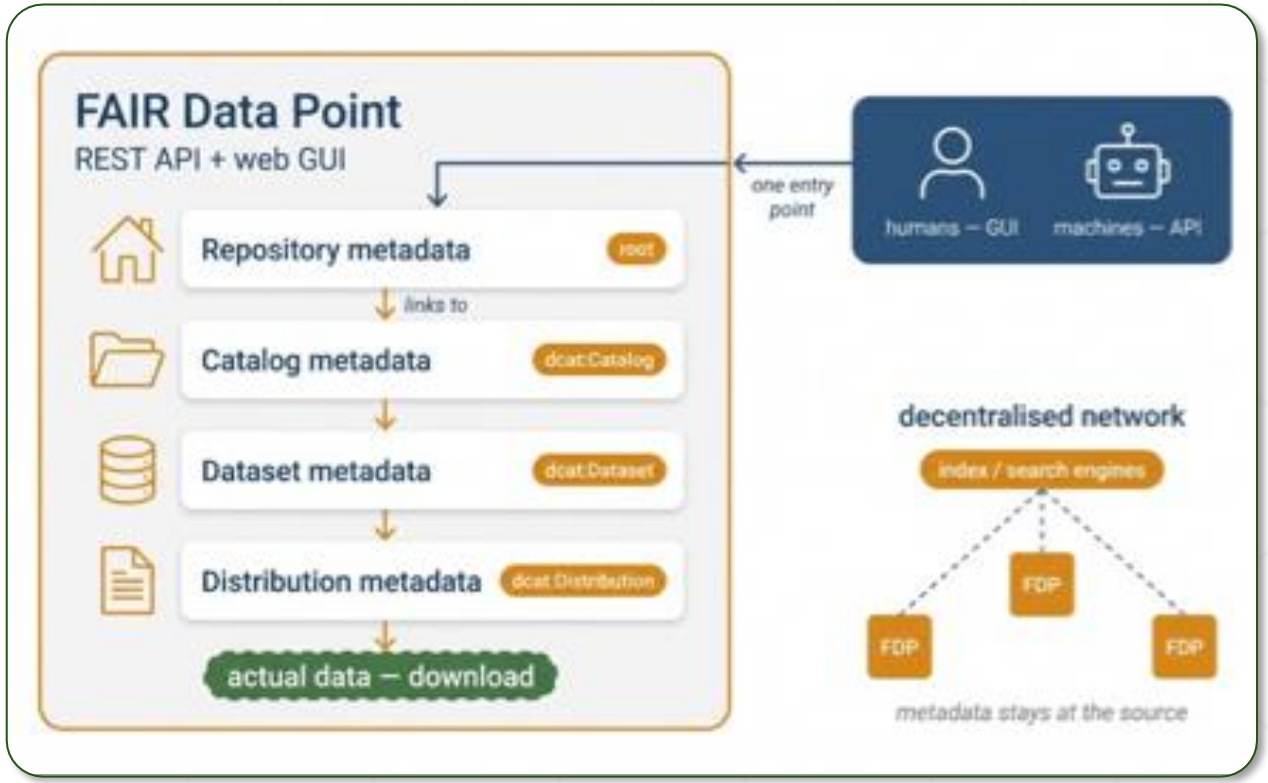
.....

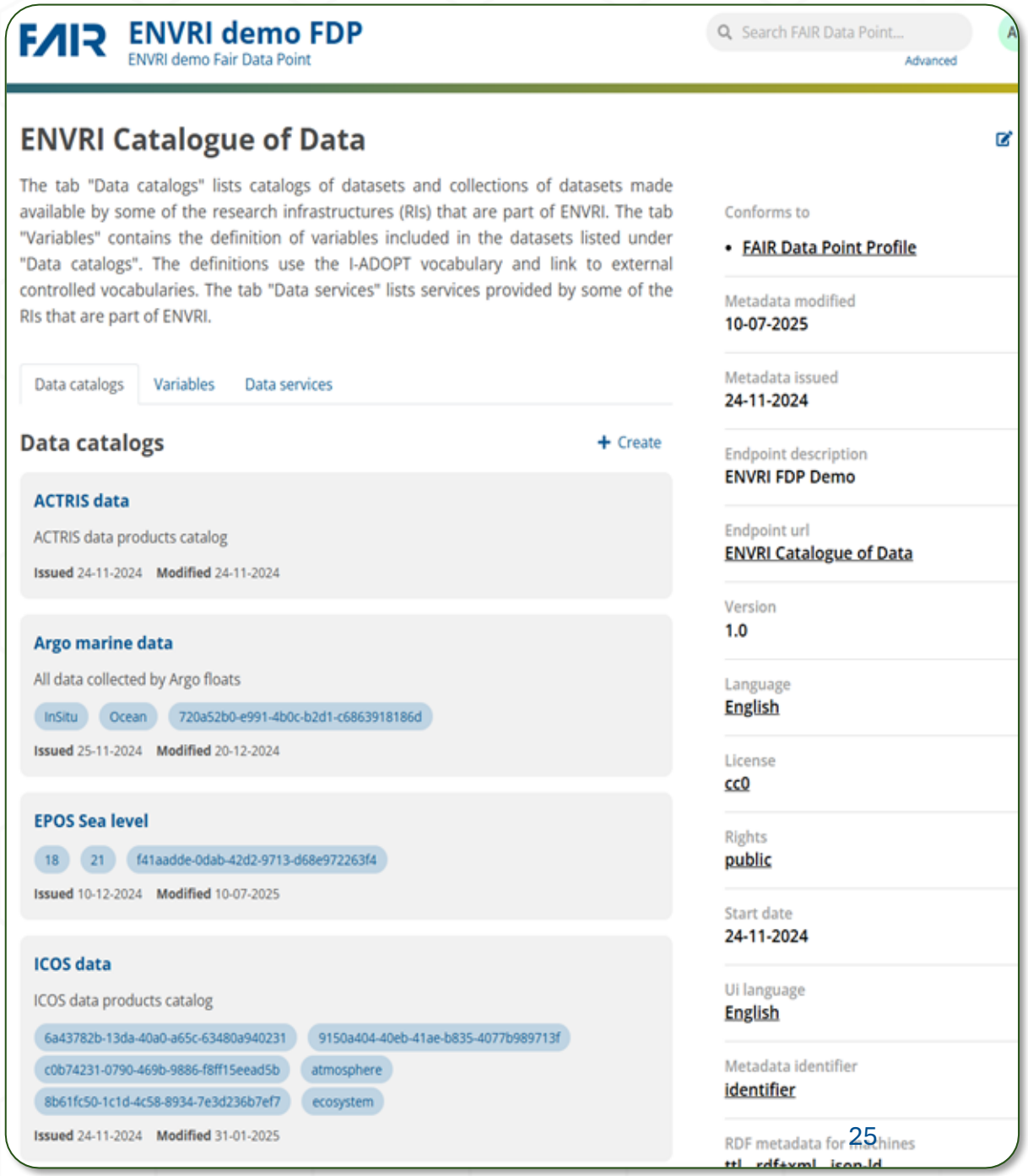
REST API

native metadata schema
.....

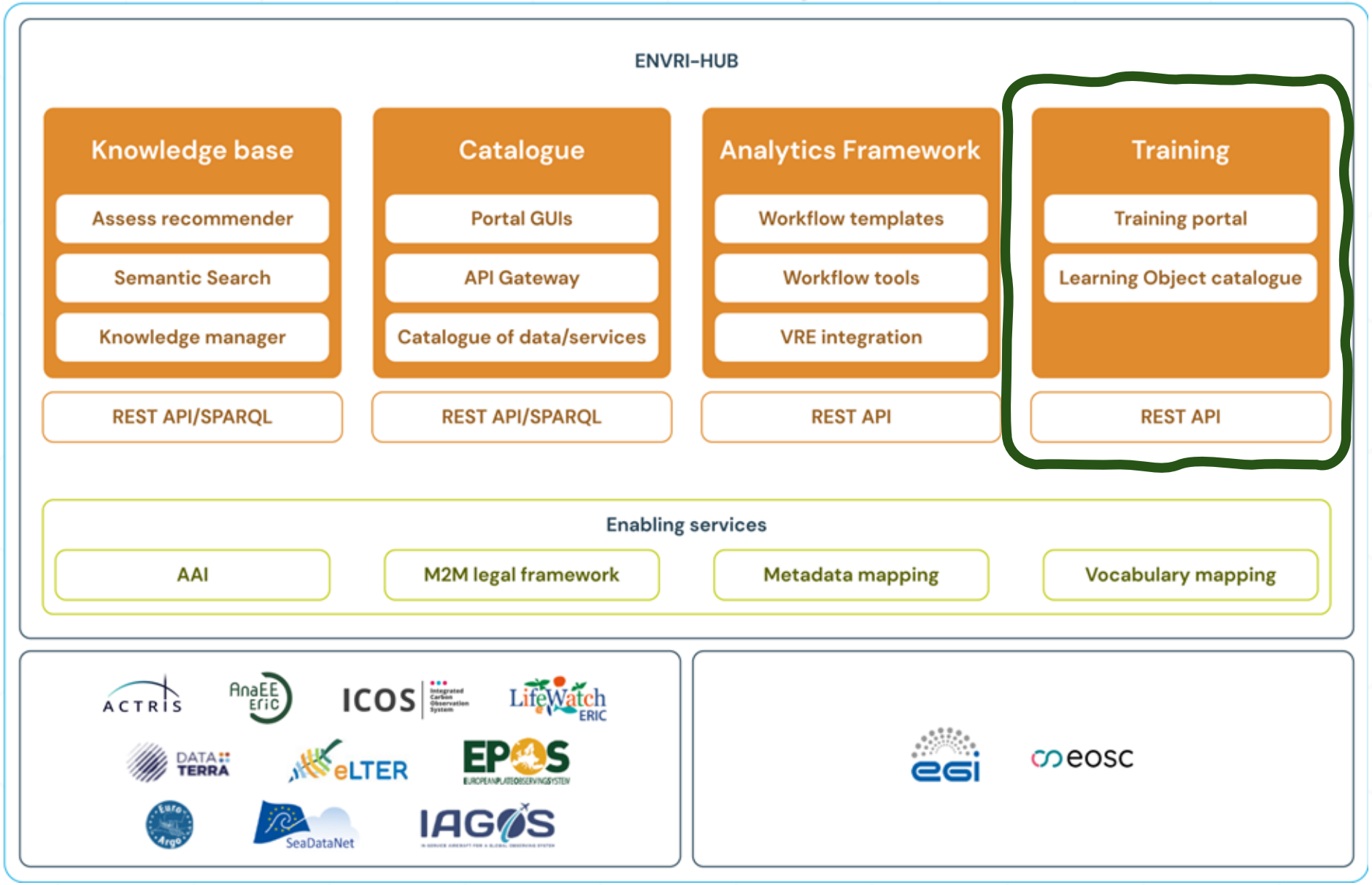
Map once, query everywhere: each RI keeps its own API and metadata model; mappers translate native records into the common schema, so a single query on the ENVRI interface reaches all federated catalogues.

ENVRI Catalogue of Data (FDP)

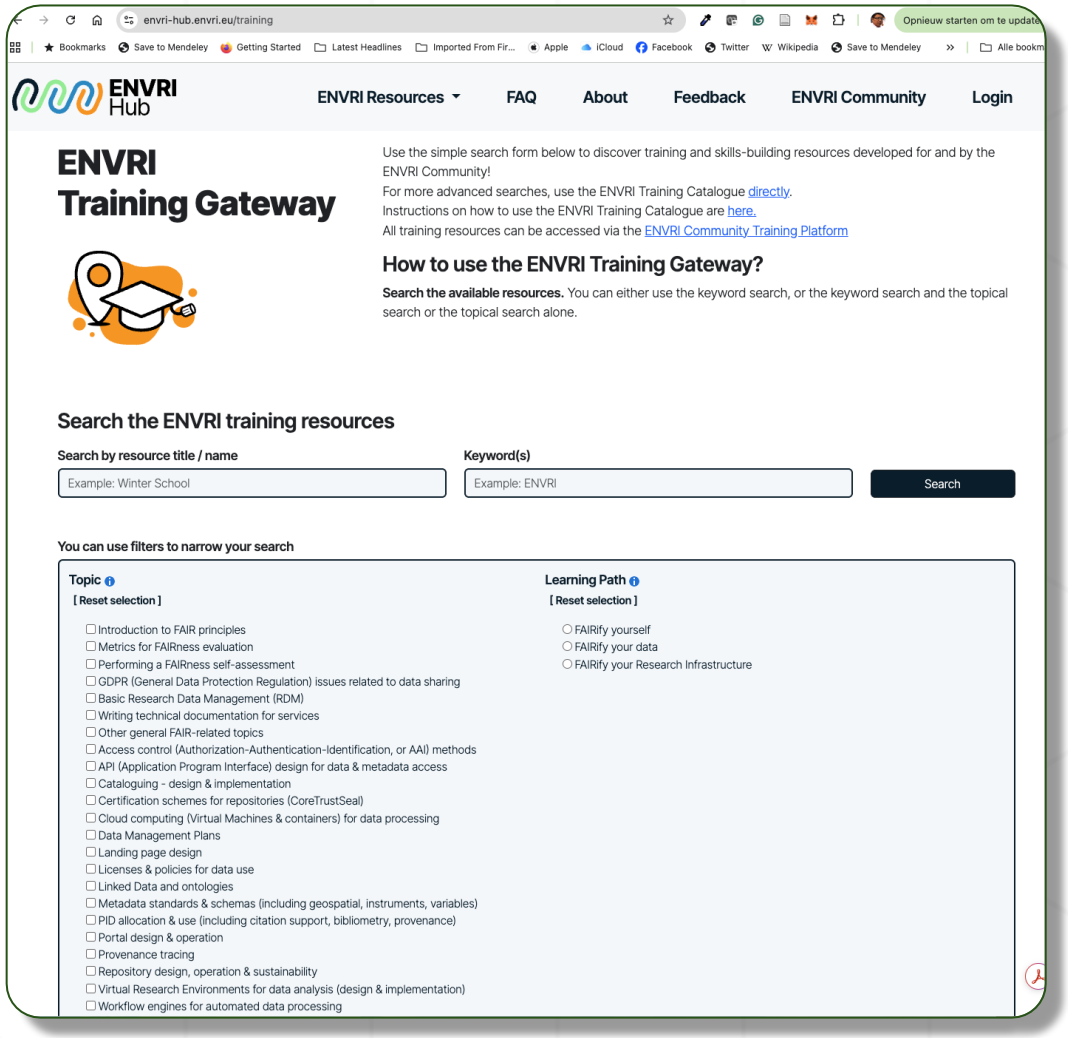




Architecture of ENVRI-HUB



Training


envri-hub.envri.eu/training
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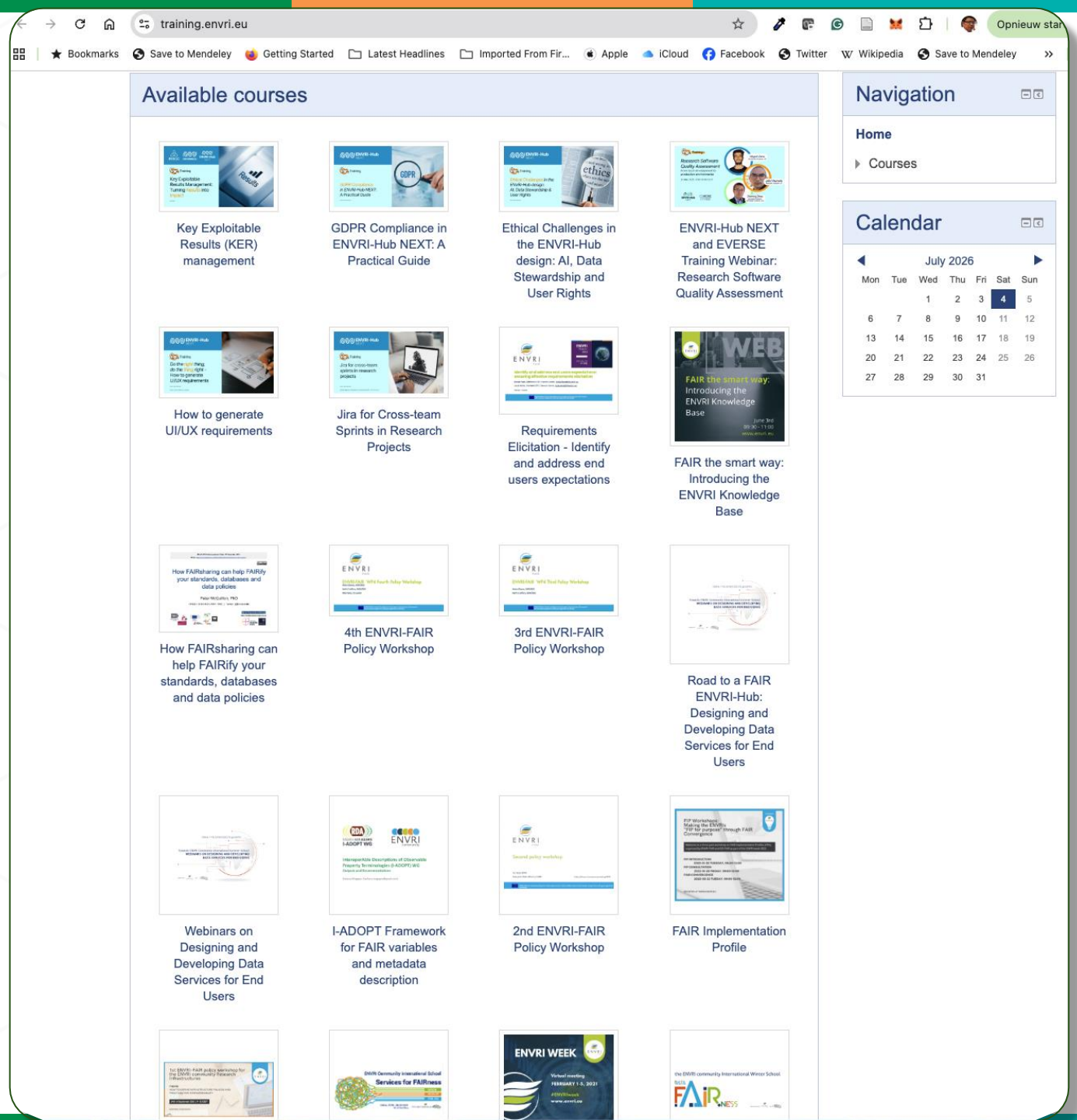
ENVRI Resources
FAQ
About
Feedback
ENVRI Community
Login
ENVRI Training Gateway
Use the simple search form below to discover training and skills-building resources developed for and by the ENVRI Community!
For more advanced searches, use the ENVRI Training Catalogue directly.
Instructions on how to use the ENVRI Training Catalogue are here.
All training resources can be accessed via the ENVRI Community Training Platform
How to use the ENVRI Training Gateway?
Search the available resources. You can either use the keyword search, or the keyword search and the topical search or the topical search alone.
Search the ENVRI training resources
Search by resource title / name
Example: Winter School
Keyword(s)
Example: ENVRI
Search
You can use filters to narrow your search
Topic
[Reset selection]
Introduction to FAIR principles
Metrics for FAIRness evaluation
Performing a FAIRness self-assessment
GDPR (General Data Protection Regulation) issues related to data sharing
Basic Research Data Management (RDM)
Writing technical documentation for services
Other general FAIR-related topics
Access control (Authorization-Authentication-Identification, or AAI) methods
API (Application Program Interface) design for data & metadata access
Cataloguing - design & implementation
Certification schemes for repositories (CoreTrustSeal)
Cloud computing (Virtual Machines & containers) for data processing
Data Management Plans
Landing page design
Licenses & policies for data use
Linked Data and ontologies
Metadata standards & schemas (including geospatial, instruments, variables)
PID allocation & use (including citation support, bibliometry, provenance)
Portal design & operation
Provenance tracing
Repository design, operation & sustainability
Virtual Research Environments for data analysis (design & implementation)
Workflow engines for automated data processing
Learning Path
[Reset selection]
FAIRify yourself
FAIRify your data
FAIRify your Research Infrastructure


training.envri.eu
Available courses
Key Exploitable Results (KER) management
GDPR Compliance in ENVRI-Hub NEXT: A Practical Guide
Ethical Challenges in the ENVRI-Hub design: AI, Data Stewardship and User Rights
ENVRI-Hub NEXT and EVERSE Training Webinar: Research Software Quality Assessment
How to generate UI/UX requirements
Jira for Cross-team Sprints in Research Projects
Requirements Elicitation - Identify and address end users expectations
FAIR the smart way: Introducing the ENVRI Knowledge Base
How FAIRsharing can help FAIRify your standards, databases and data policies
4th ENVRI-FAIR Policy Workshop
3rd ENVRI-FAIR Policy Workshop
Road to a FAIR ENVRI-Hub: Designing and Developing Data Services for End Users
Webinars on Designing and Developing Data Services for End Users
I-ADOPT Framework for FAIR variables and metadata description
2nd ENVRI-FAIR Policy Workshop
FAIR Implementation Profile
ENVRI WEEK
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July 2026
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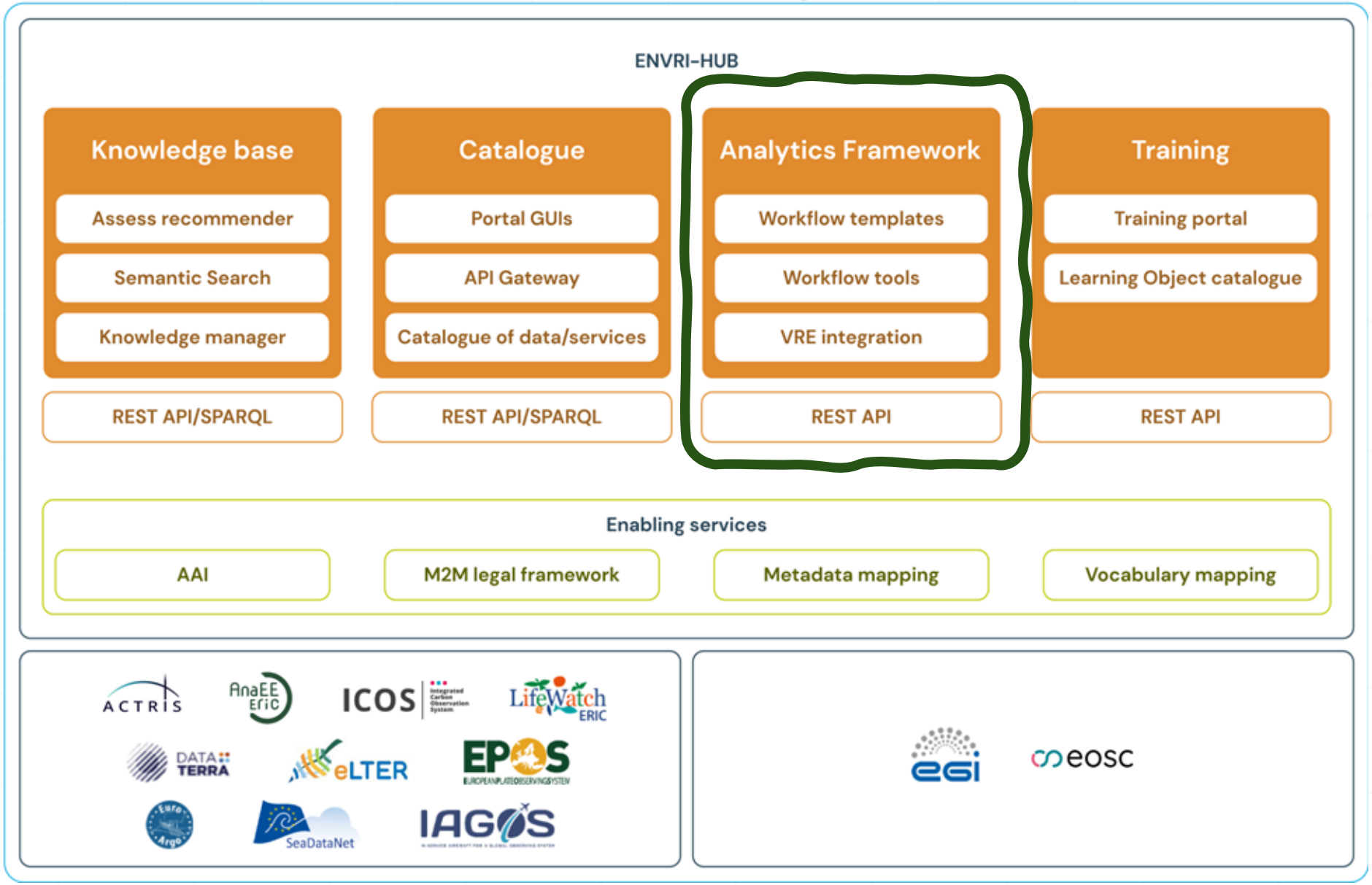
Architecture of ENVRI-HUB



use your own VRE or check the test VRE

Programmatic access to the ENVRI-Hub services

```
#%pip install matplotlib cartopy numpy pandas
```

Proof of concept notebook of notebooks

This notebook shows the PoC python library (ehnpy) in action.

```
import ecv_data_access.functions as functions
import matplotlib.pyplot as plt
import cartopy.crs as ccrs
import cartopy.feature as cfeature
import numpy as np
import pandas as pd
```

```
## Argo & SDN
#EXV017 Sea-surface temperature (SDN / Euro-Argo)                    -->
#EXV018 Subsurface temperature (SDN / Euro-Argo)                     -->
#EXV019 Sea Surface Salinity (SDN / Euro-Argo)                       -->
#EXV020 Subsurface Salinity (SDN / Euro-Argo)                        -->
#EXV028 Oxygen (SDN / Euro-Argo)                                    -->
#EXV029 Nutrients (SDN / Euro-Argo)                                 -->
#EXV033 Ocean color (SDN / Euro-Argo)                               -->

## ACTRIS & SDN
#EXV011 Cloud properties (ACTRIS / SDN)                              ?
#EXV016 Aerosol properties (ACTRIS / SDN)                           -->

## ICOS & SDN
#EXV013 Carbon dioxide, methane and other greenhouse gases (ICOS / SDN)  -->

## EPOS & SDN
#EXV023 Sea level (SDN / EPOS)                                       -

## Individual RIs
#EXV014 Ozone                                                        ?
#EXV015 Precursors (supporting the aerosol and ozone ECVs) (IAGOS)  -->
#EXV022 Subsurface Currents (Euro-Argo)                              -
#EXV030 Ocean Inorganic Carbon (SDN)                                 -
#EXV039 Soil moisture (ICOS)                                         -
```

```
exv = "EXV015"
region=(10, 20, 45, 65)
time=("2020-01-01", "2020-01-10")
samplingheight=(0, 100)
```

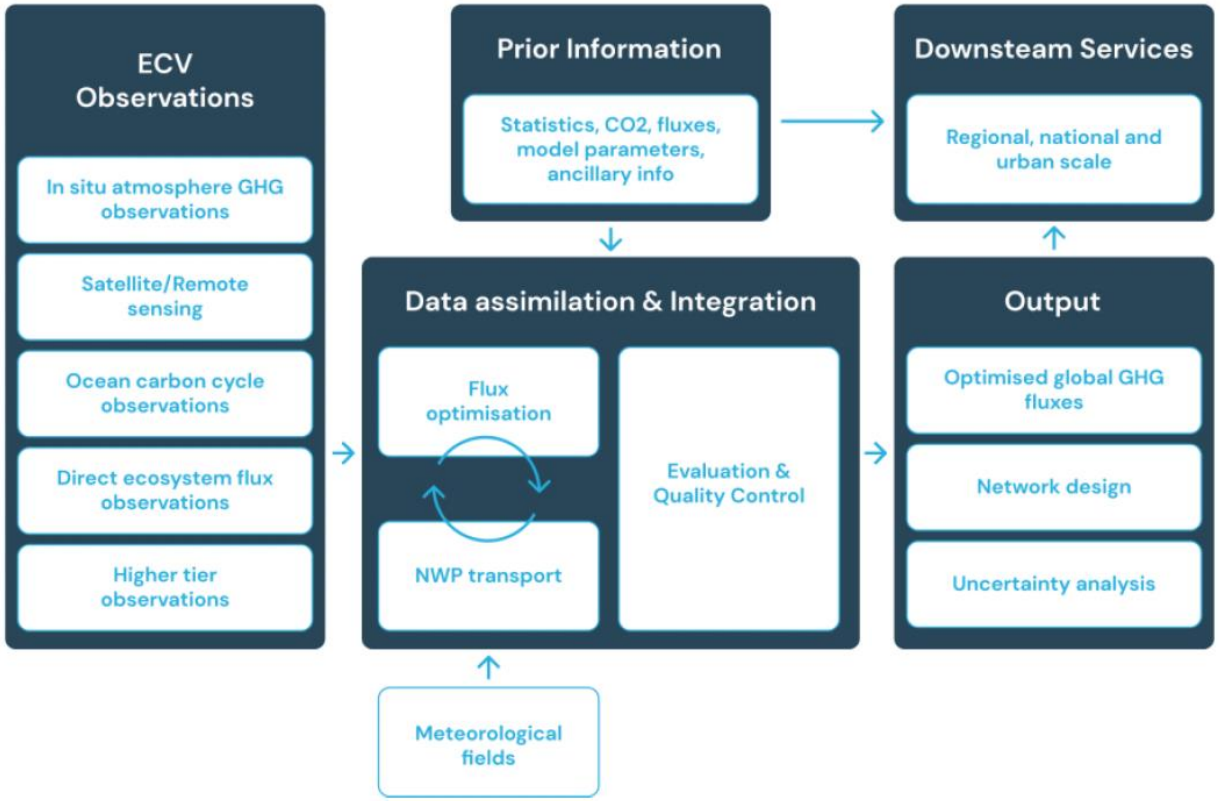
```
data = functions.get_data(
    exv_variable=exv,
    region=region,
    time=time,
    samplingheight=samplingheight
)
```

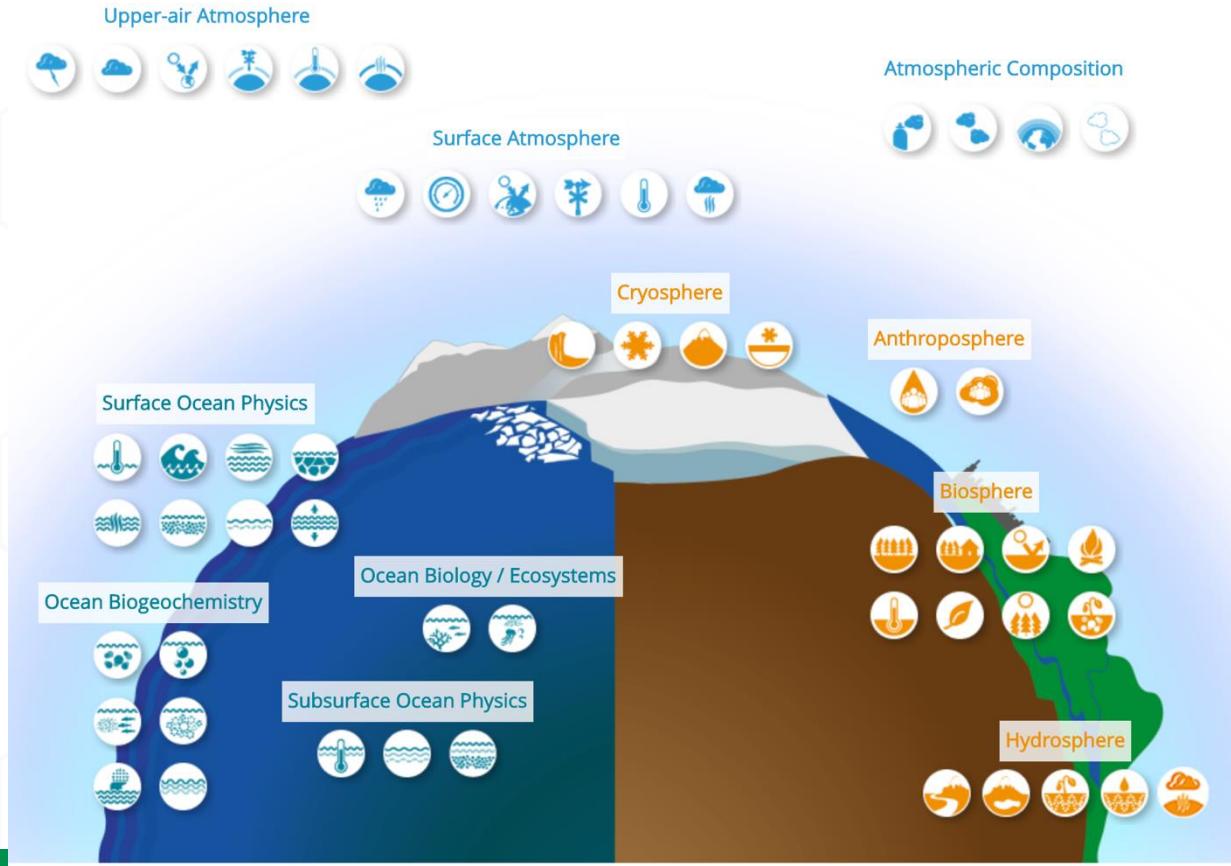
```
[2025-09-05 12:30:47] [seadatanet.py:get_data] Fetching data from SeaDataNet CDI Beacon API...
[2025-09-05 12:30:47] [seadatanet.py:filter_unavailable_columns] Filtering available columns...
[2025-09-05 12:30:49] [seadatanet.py:get_data] Variables: []
[2025-09-05 12:30:49] [seadatanet.py:get_data] No valid variables found. Please check the provided variables.
[2025-09-05 12:30:50] [argo.py:get_data] Fetching data from Argo using Argopy...
[2025-09-05 12:30:50] [argo.py:get_data] No variables
Enter your username:  alex.vermeulen@nateko.lu.se
Enter your password:  ........
[2025-09-05 12:31:47] [icos.py:get_data] Fetching data from ICOS...
[2025-09-05 12:31:47] [icos.py:exec_icos_sparql_query] SPARQL query status code: 200
[2025-09-05 12:31:47] [icos.py:get_data] Found 0 data objects.
[2025-09-05 12:31:47] [icos.py:get_data] No data objects found for the given query parameters.
[2025-09-05 12:31:48] [iagos.py:get_data] Fetching data from IAGOS...
CO
[2025-09-05 12:31:57] [iagos.py:download_to_file] Downloading https://services.iagos-data.fr/prod/v2.0/13/loadNetcdfFile?fileId=https://doi.org/10.25326/6
```

2. Essential Climate Variables (ECV)

Essential climate variables

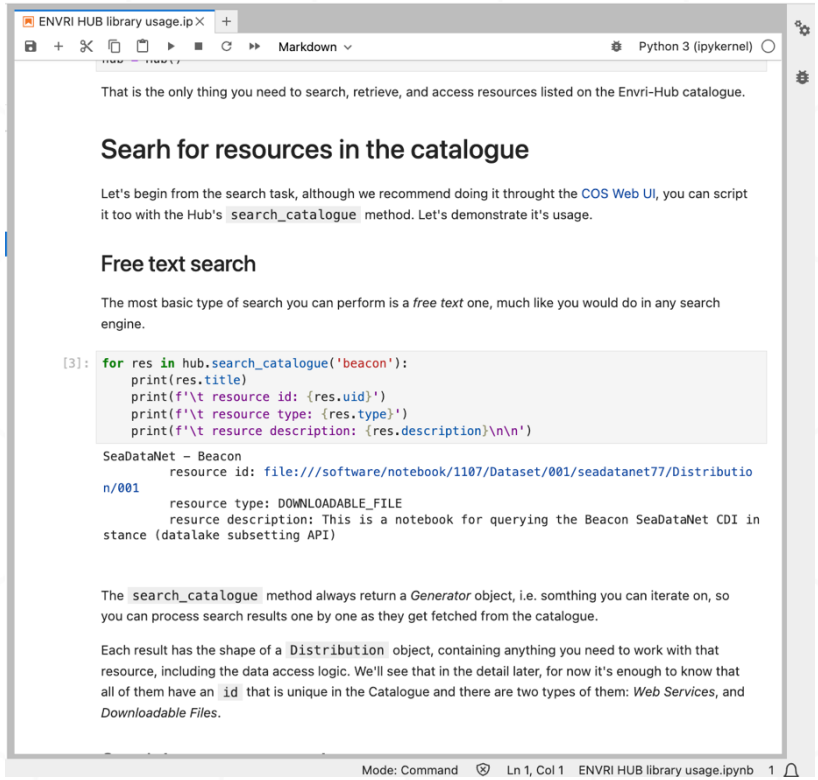
*Essential Climate Variables as defined by the Global Climate Observing System; there are **54 focused** on the atmosphere, cryosphere, oceans, anthroposphere, biosphere, and the hydrosphere.*

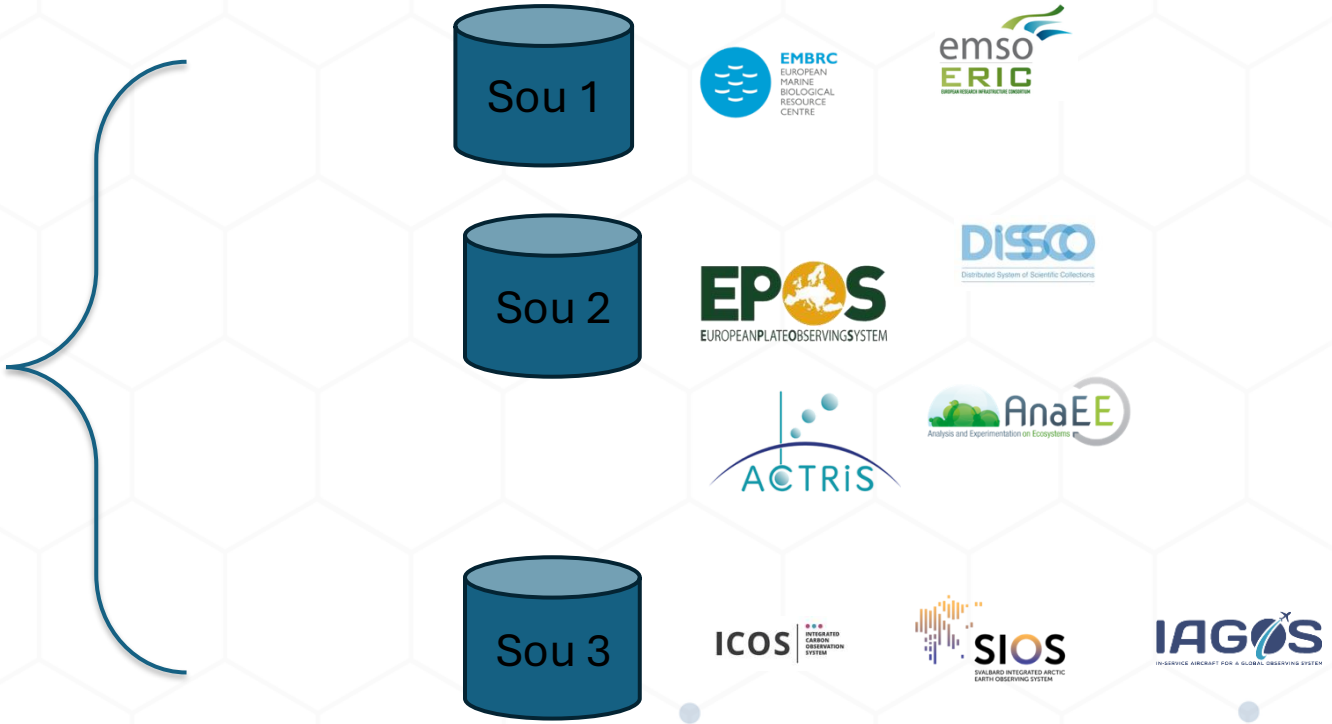




Essential climate variables

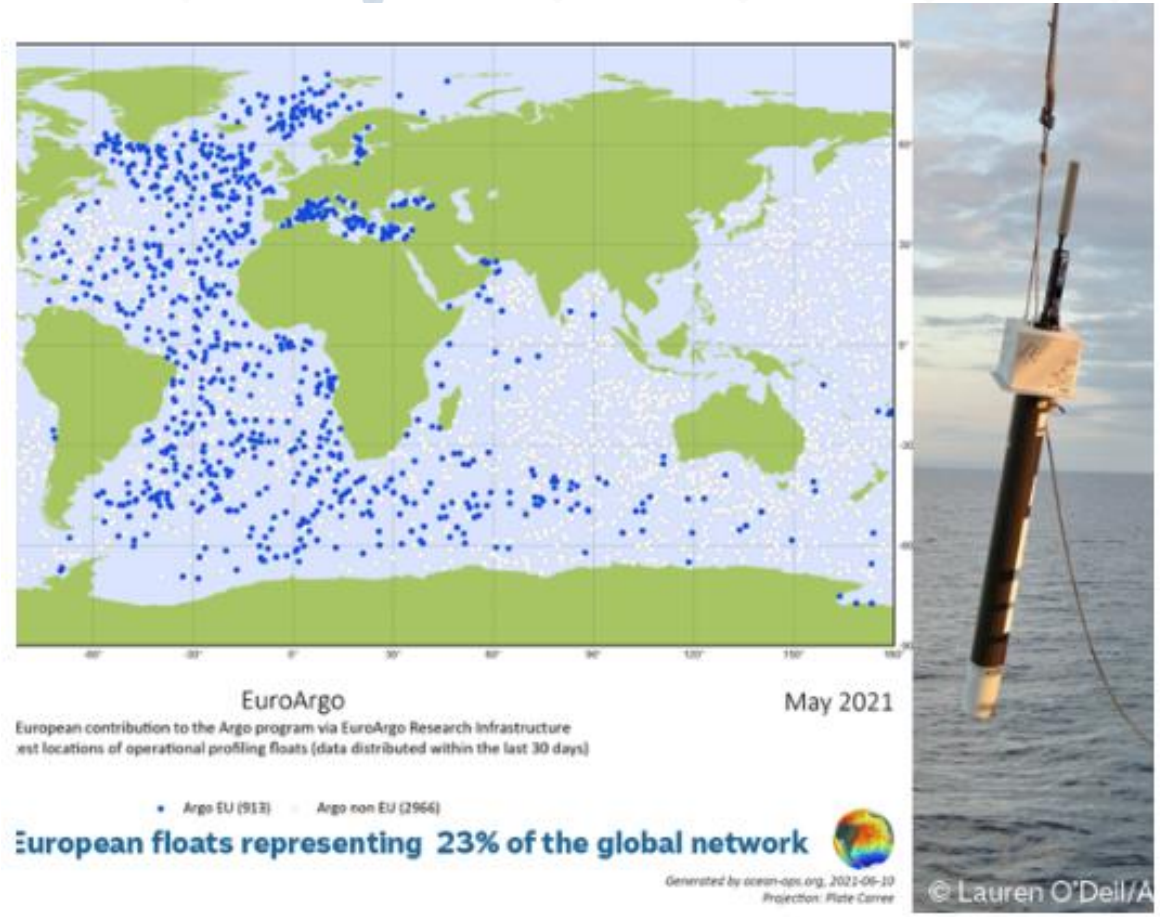
- Variables are critical for observing and monitoring a given facet of the Earth system.

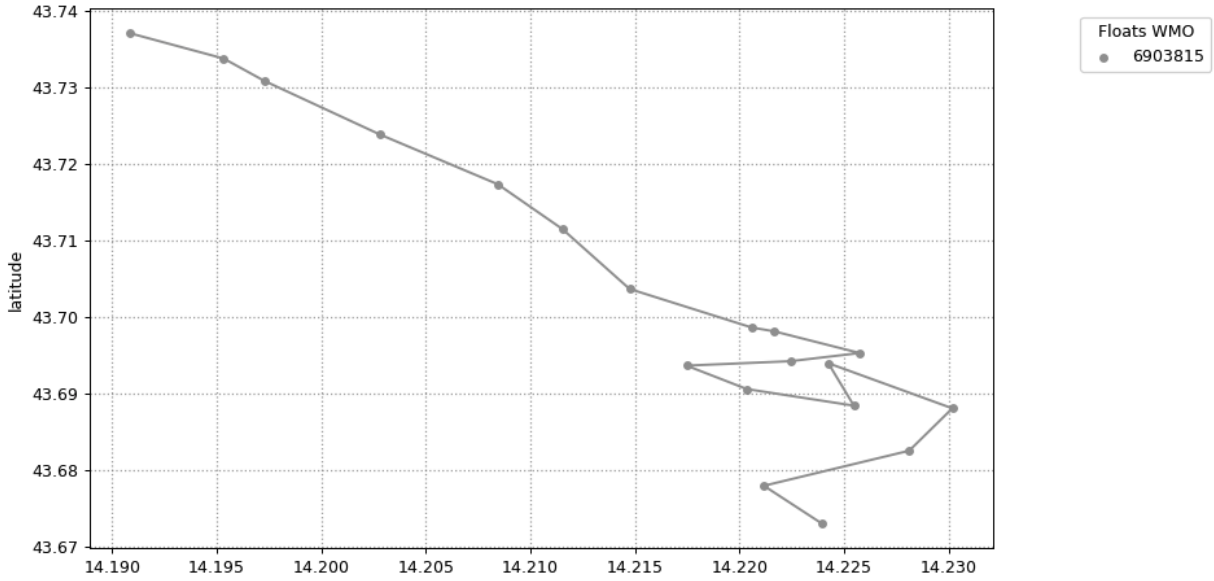


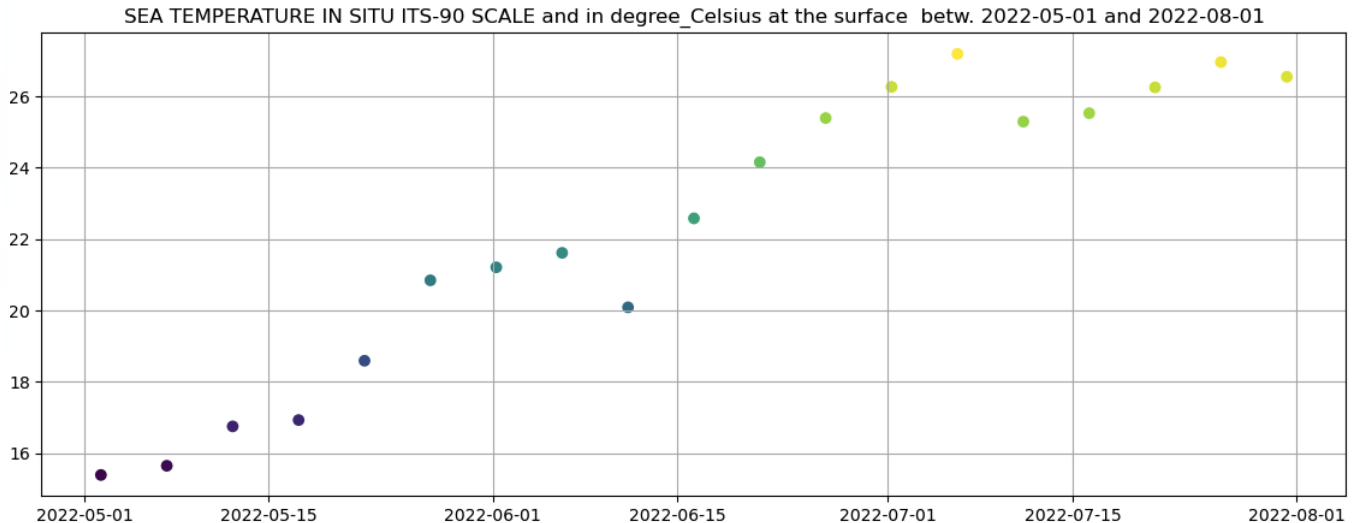


Tier one research software

ENVRI EuroArgo RI

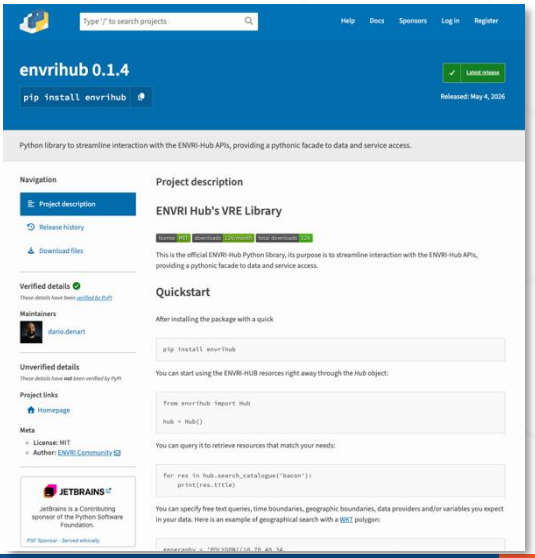


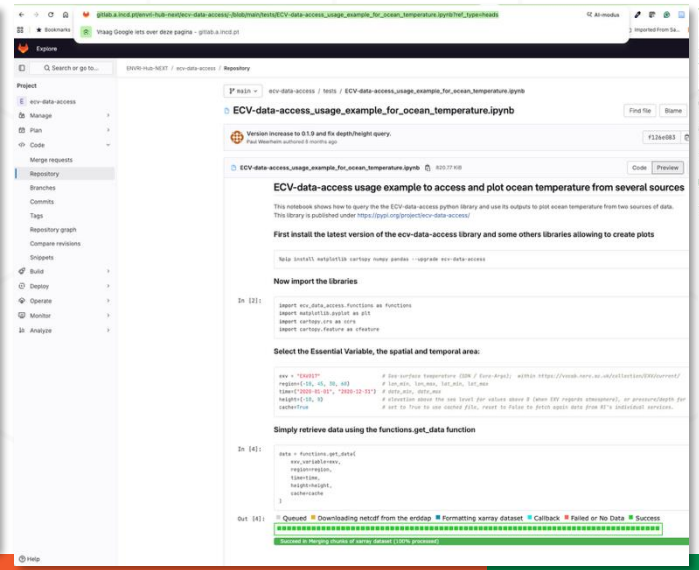


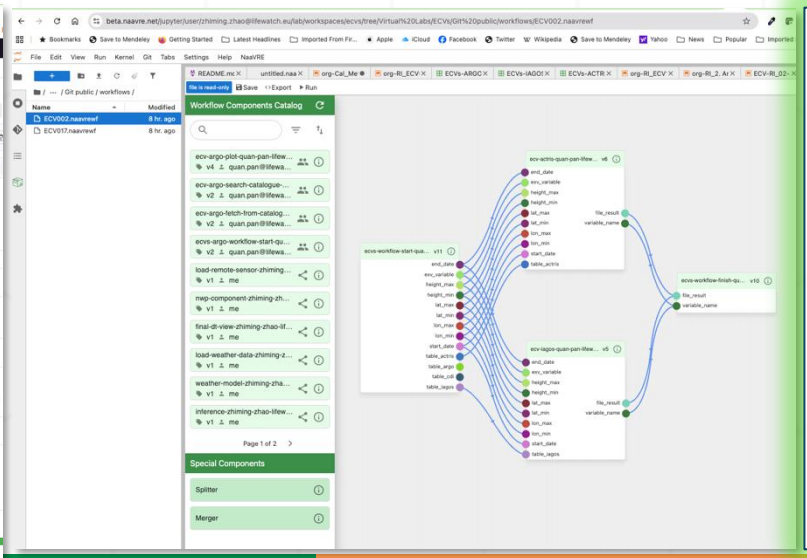


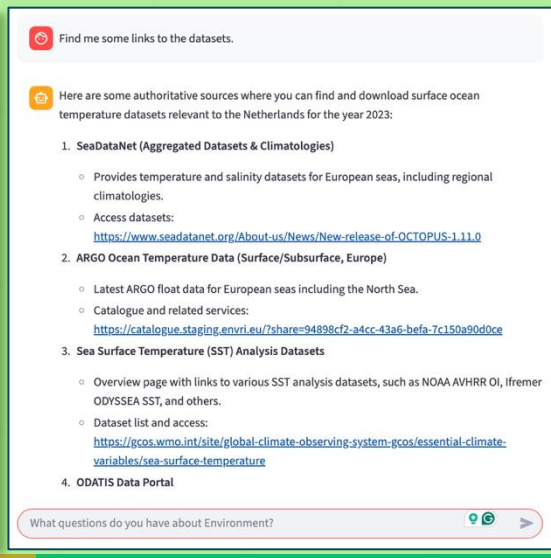
ENVRI-HUB

- Python library for ECV data access
- ECV notebook
- ECV composible workflow
- LLM enhanced ECV workflow creation









Environmental Expert: enhance other search systems

Environmental Expert...

Ask any question about the Environment and Earth Science

How do I co
the Surface
temperatu

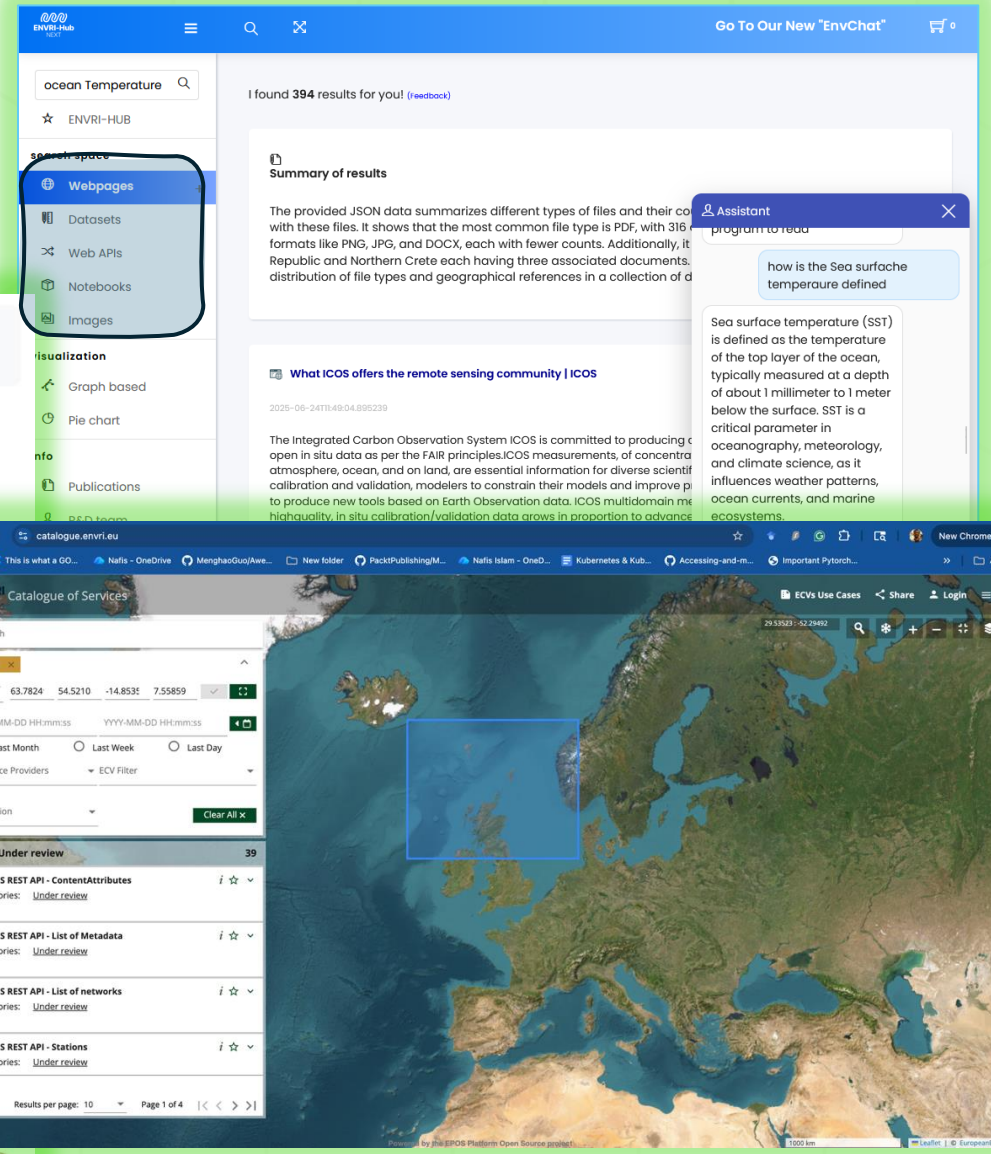
What questions d nment?

Find me some links to the datasets.

Here are some authoritative sources where you can find and download surface ocean temperature datasets relevant to the Netherlands for the year 2023:

1. **SeaDataNet (Aggregated Datasets & Climatologies)**
   - Provides temperature and salinity datasets for European seas, including regio climatologies.
   - Access datasets: https://www.seadatanet.org/About-us/News/New-release-of-OCTOPUS-1.11.
2. **ARGO Ocean Temperature Data (Surface/Subsurface, Europe)**
   - Latest ARGO float data for European seas including the North Sea.
   - Catalogue and related services: https://catalogue.staging.envri.eu/?share=94898cf2-a4cc-43a6-befa-7c150a90
3. **Sea Surface Temperature (SST) Analysis Datasets**
   - Overview page with links to various SST analysis datasets, such as NOAA AVHR ODYSSEA SST, and others.
   - Dataset list and access: https://gcos.wmo.int/site/global-climate-observing-system-gcos/essential-cli variables/sea-surface-temperature
4. **ODATIS Data Portal**

What questions do you have about Environment?



Environmental Expert: for problem solving

Find me the medhods to cal

Here are methods and speci
Ocean Temperature:

1. GCOS Measurement Spe
   - Horizontal Resolutio
     100 km.
   - Temporal Resolution
   - Timeliness: Data sho
   - Required Measureme
   - These specifications
     variability and chang

   More details:
   https://gcos.wmo.int/sit
   variables/sea-surface-te

2. EOV (Essential Ocean Va
   - Provides standardize
   - Measurements derive
     buoys, and ships.
   - Describes data proce

What questions do you have abou

How do I use the envri-hu

You can use the envrihub
streamlined data and ser

1. Install the library:

```
pip install envrih
```

2. Example usage (fetchi

```
from envrihub impo

# Fetch a dataset
res = hub.fetch_fr
# Access as a byte
byte_stream = res.
# Or download the
res.dao.download('
```

3. For interacting with sp

```
from envrihub.data

# Build a client f
```

What questions do you have ab

Environmental Expert

Ask any question about the Environment and Earth Science

Write a python program to plot the sea surface temperature of the atlantic ocean using argopy

To plot the sea surface temperature (SST) of the Atlantic Ocean using the argopy library in Python, follow these steps:

1. Install the required packages (argopy, xarray, matplotlib, cartopy).
2. Use argopy to fetch data from the Atlantic region.
3. Select data for sea surface temperature.
4. Plot the data.

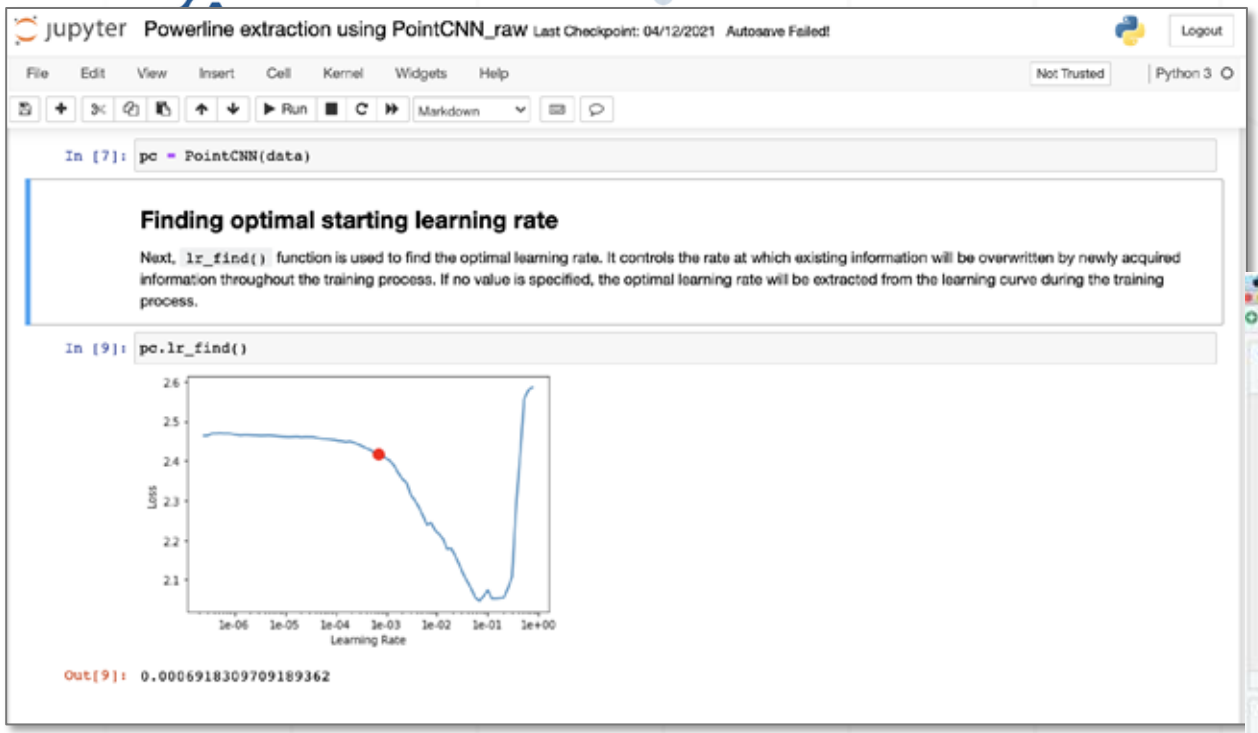
Here's a complete example:

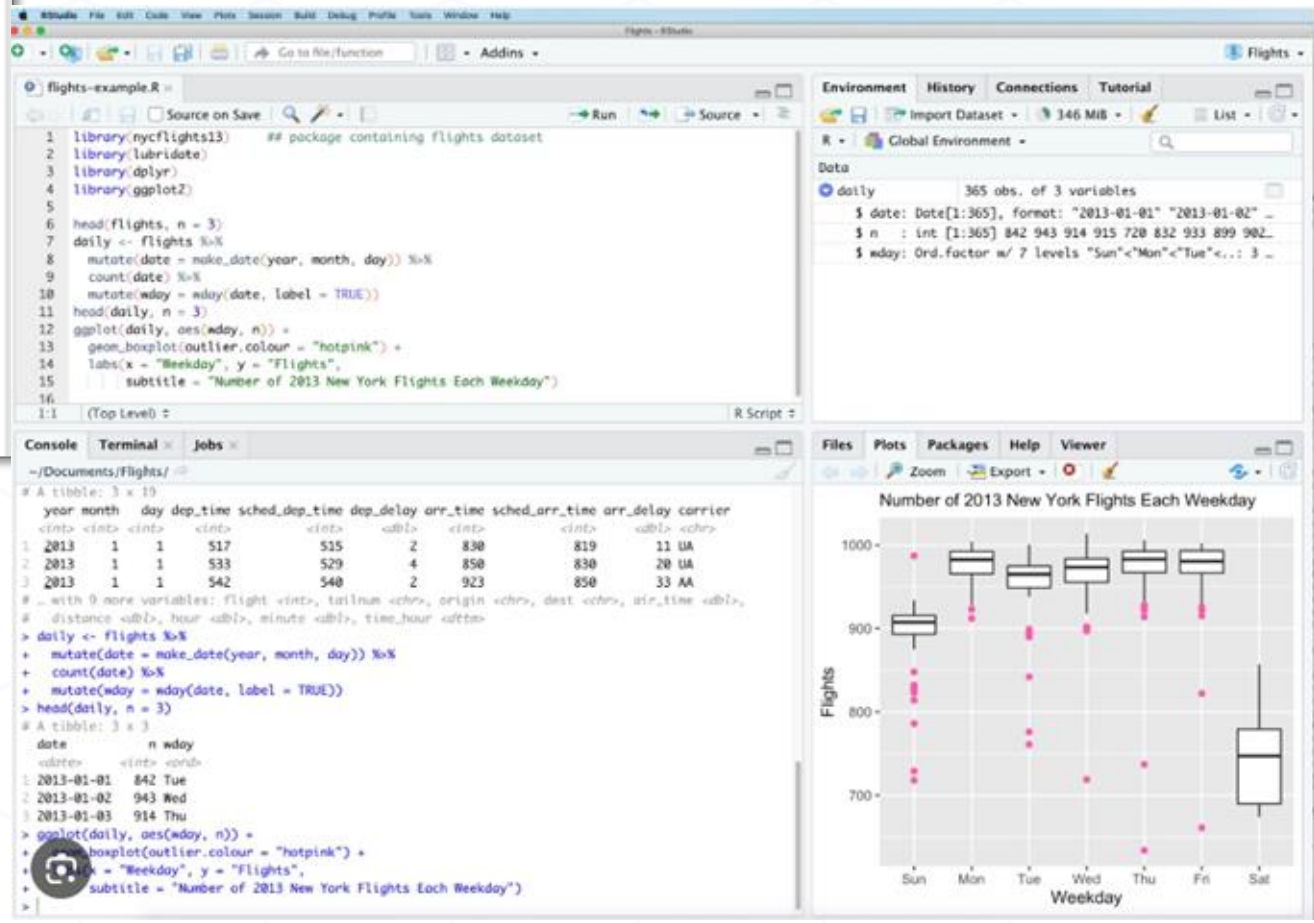
```
import matplotlib.pyplot as plt
import cartopy.crs as ccrs
import xarray as xr
from argopy import DataFetcher

# Define the Atlantic Ocean region (lat/lon bounds)
atlantic_bounds = [
```

Write a python program to plot the sea surface temperature of the atlantic ocean using argopy

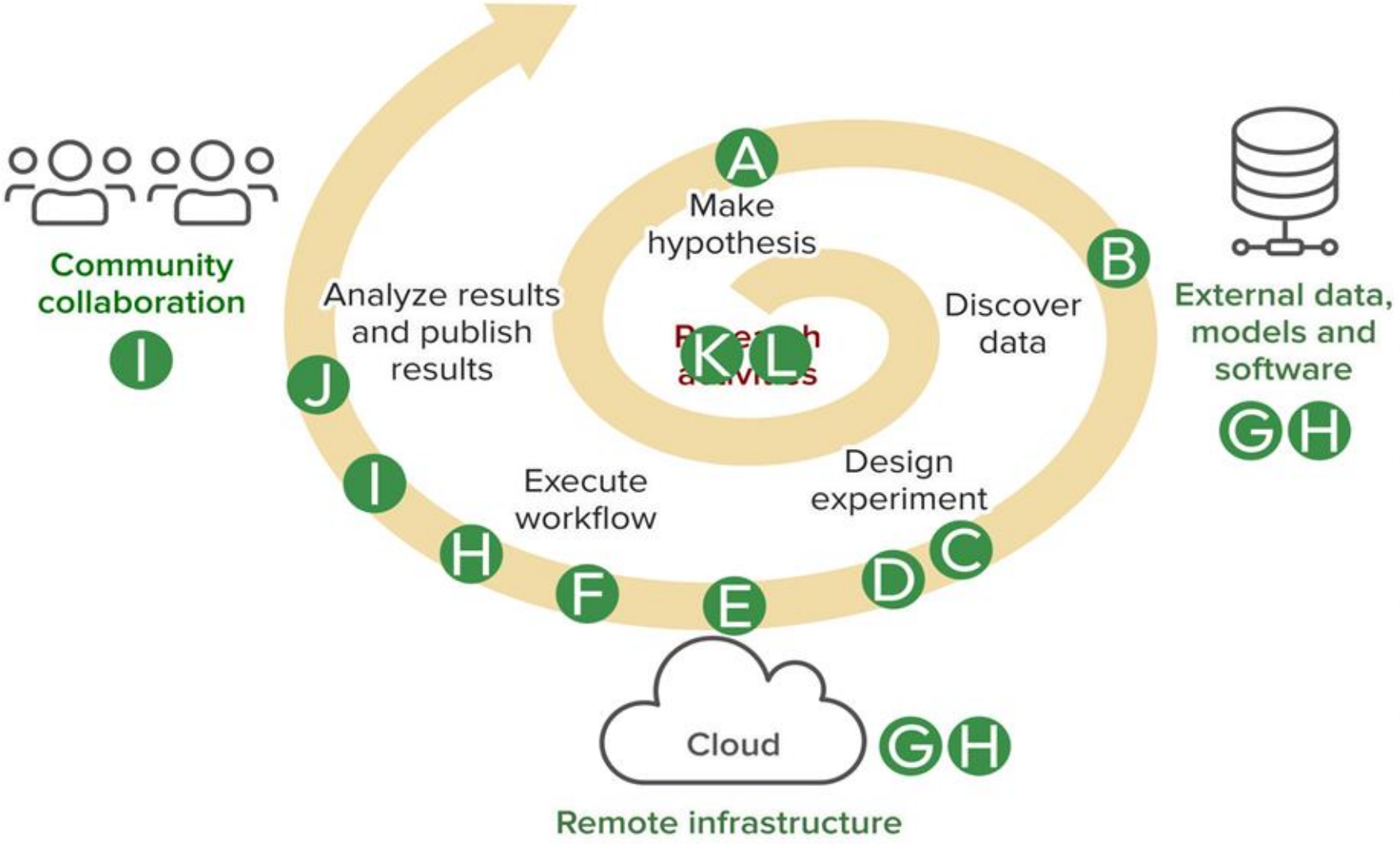
3. Jupyter notebook and Virtual Research Environment?

Daily environment: Jupyter, R-Studio



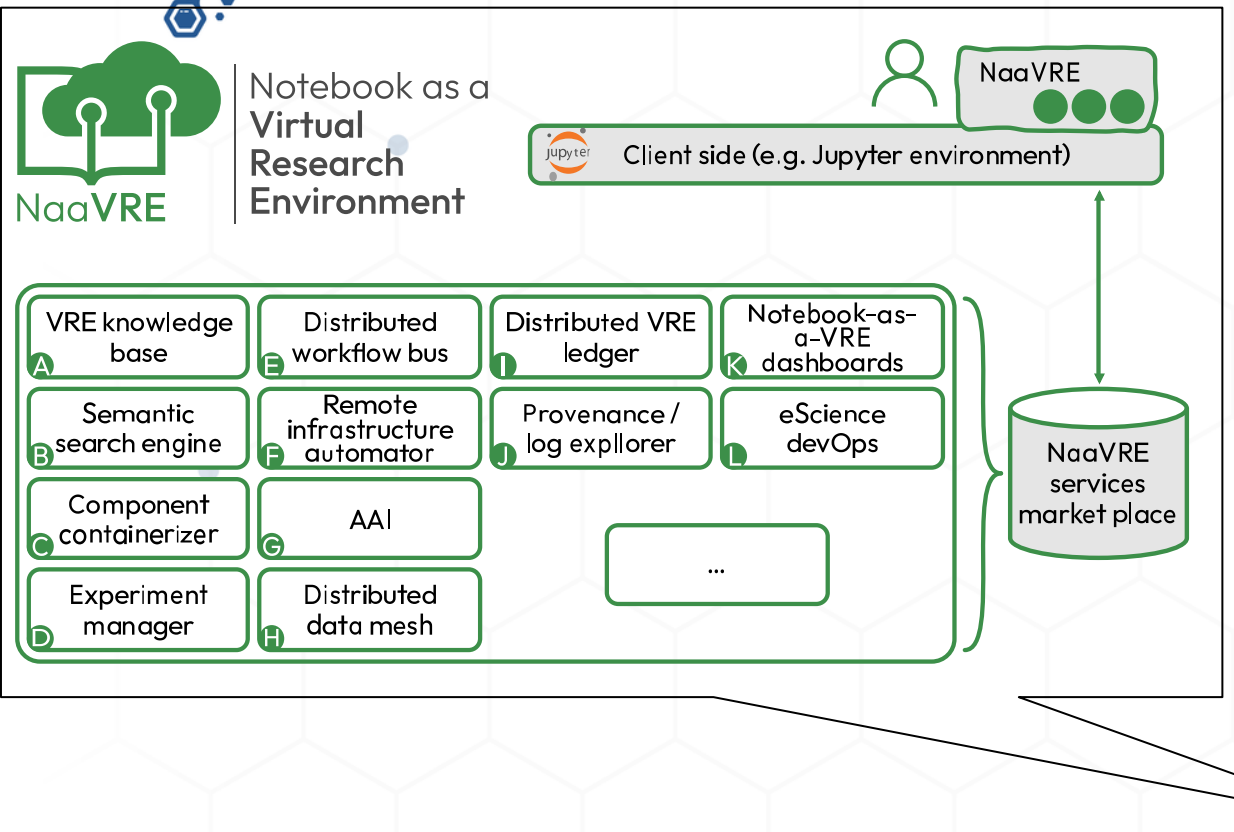


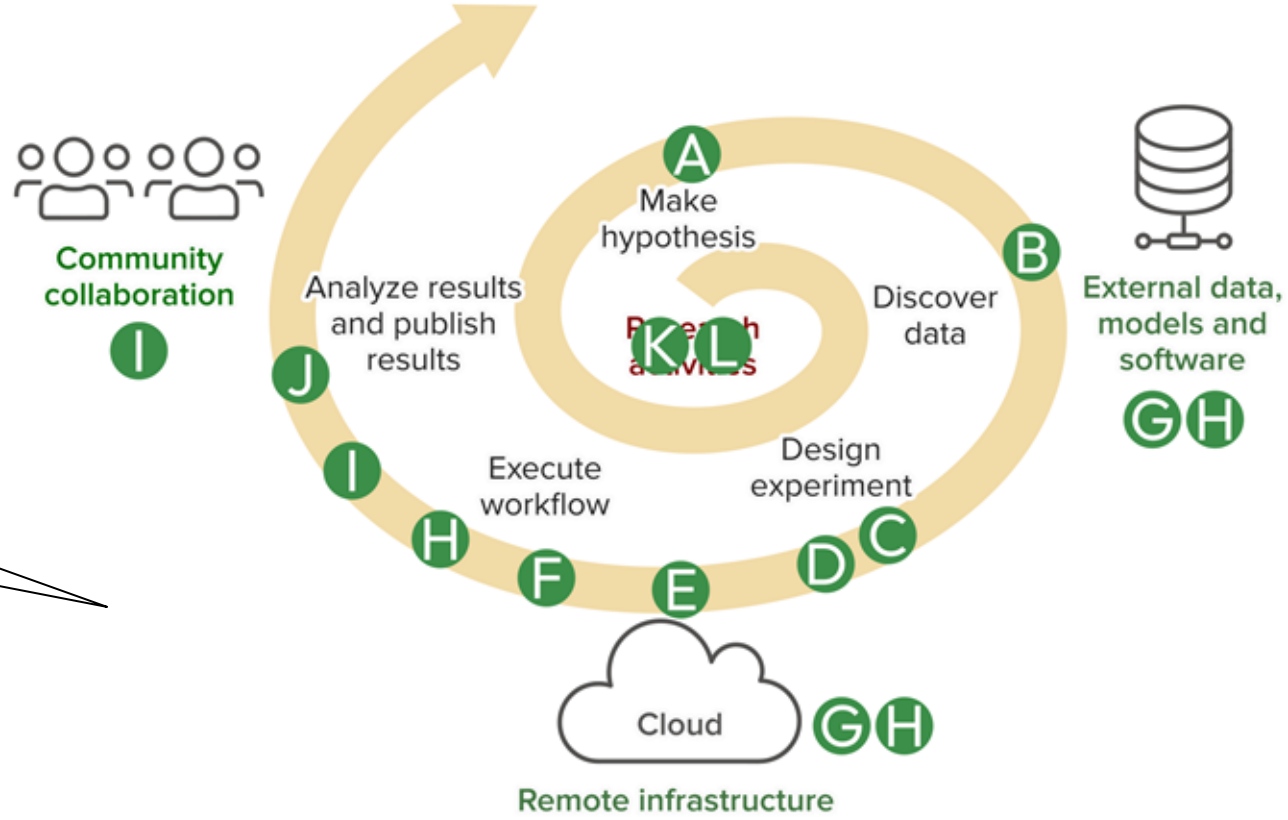
Challenges



Zhao, Z., Koulouzis, S., Bianchi, R., Farshidi, S., Shi, Z., Xin, R., Wang, Y., Li, N., Shi, Y., Timmermans, J., Kissling, W.D.: Notebook-as-a-VRE (NaaVRE): From private notebooks to a collaborative cloud virtual research environment. Softw Pract Exp. spe.3098 (2022). https://doi.org/10.1002/spe.3098.

Research activities and Jupyter extensions





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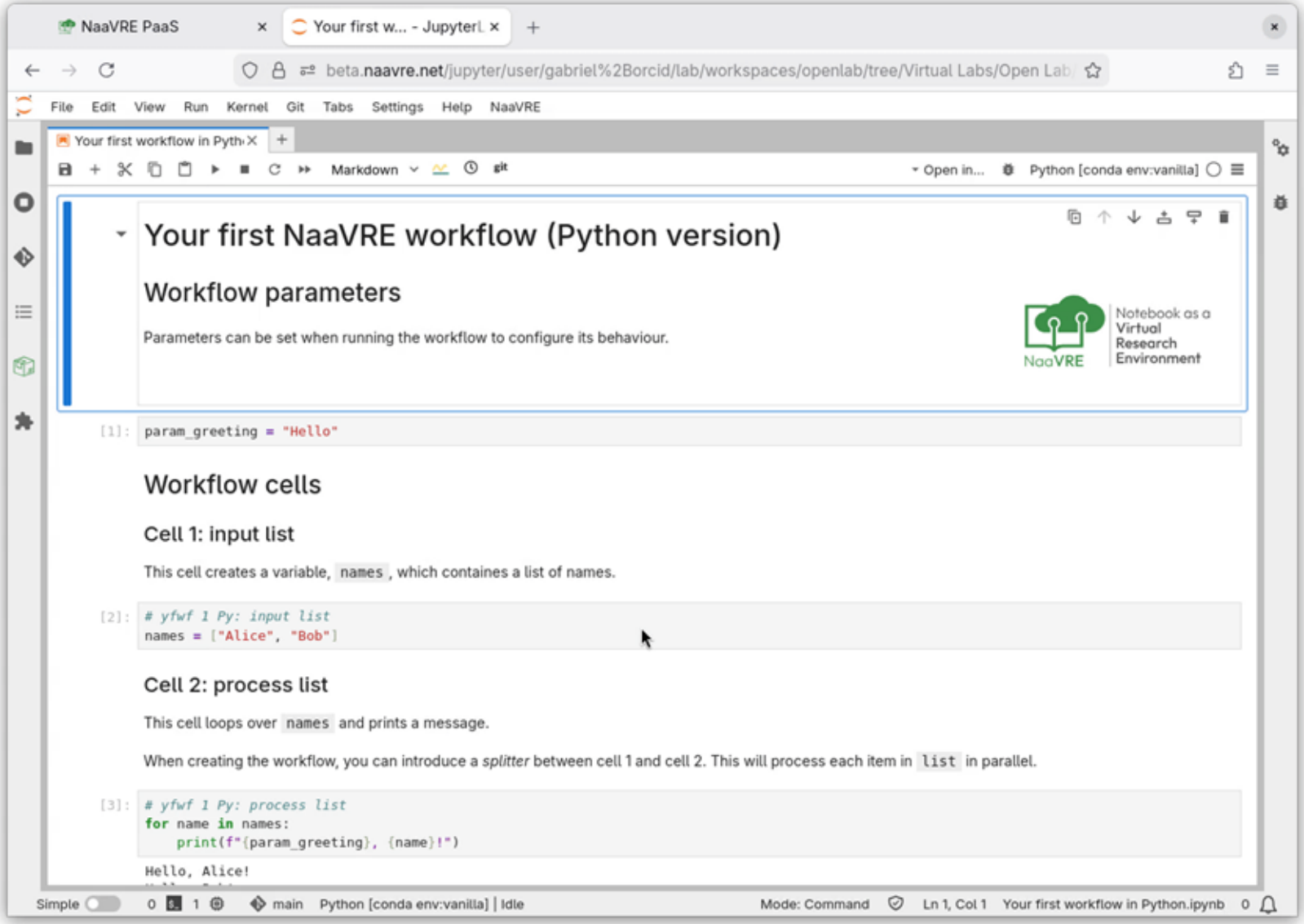
From notebooks to cloud workflows

Containerize notebook cell

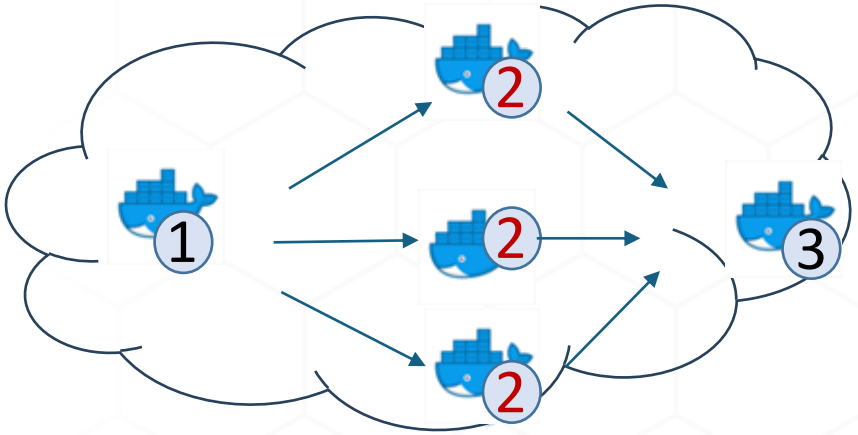
Encapsulate **user-selected cells** and **containerize** them as standardized **reusable workflow components**.

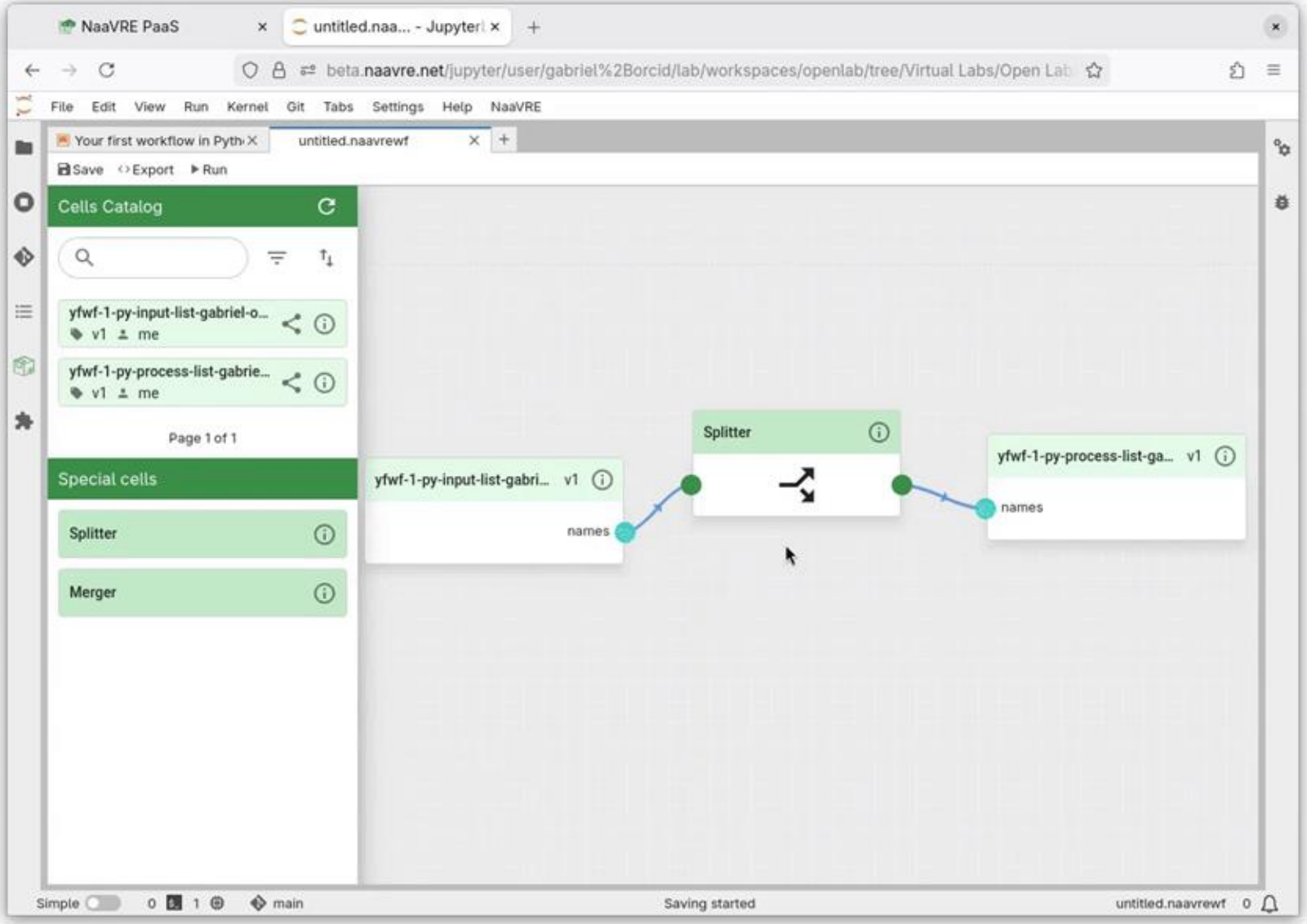
Code cell → docker



From notebooks to cloud workflows

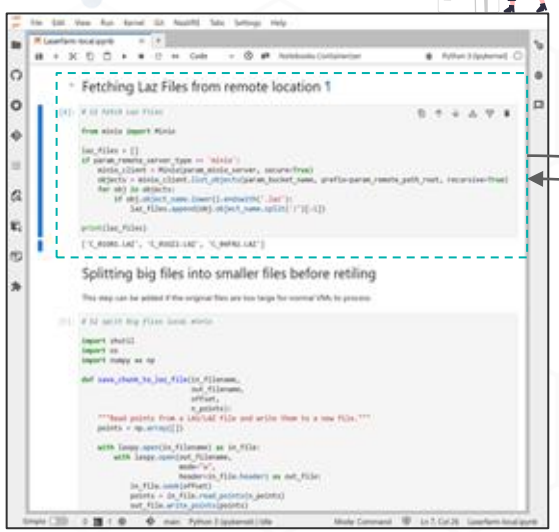
Run a workflow





From notebooks to cloud workflows

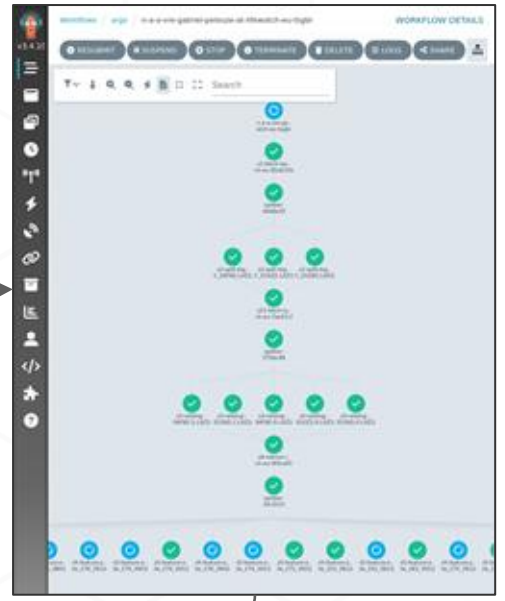
Notebook cell



Workflow component

Workflow template

Workflow run

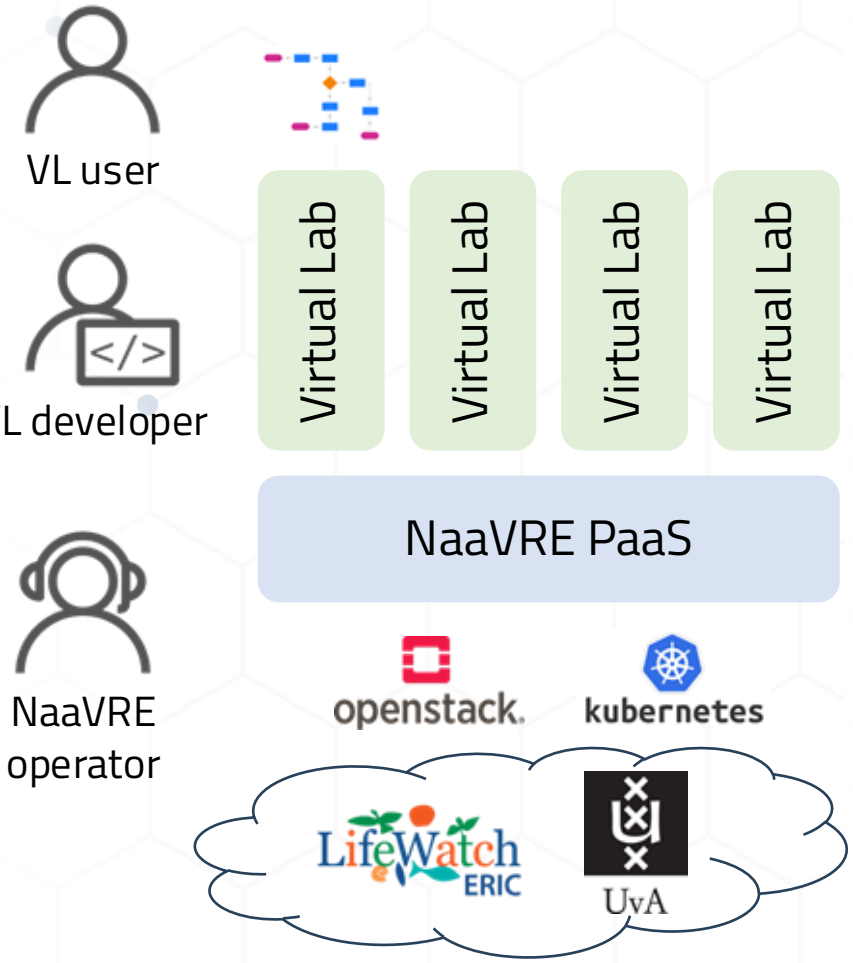


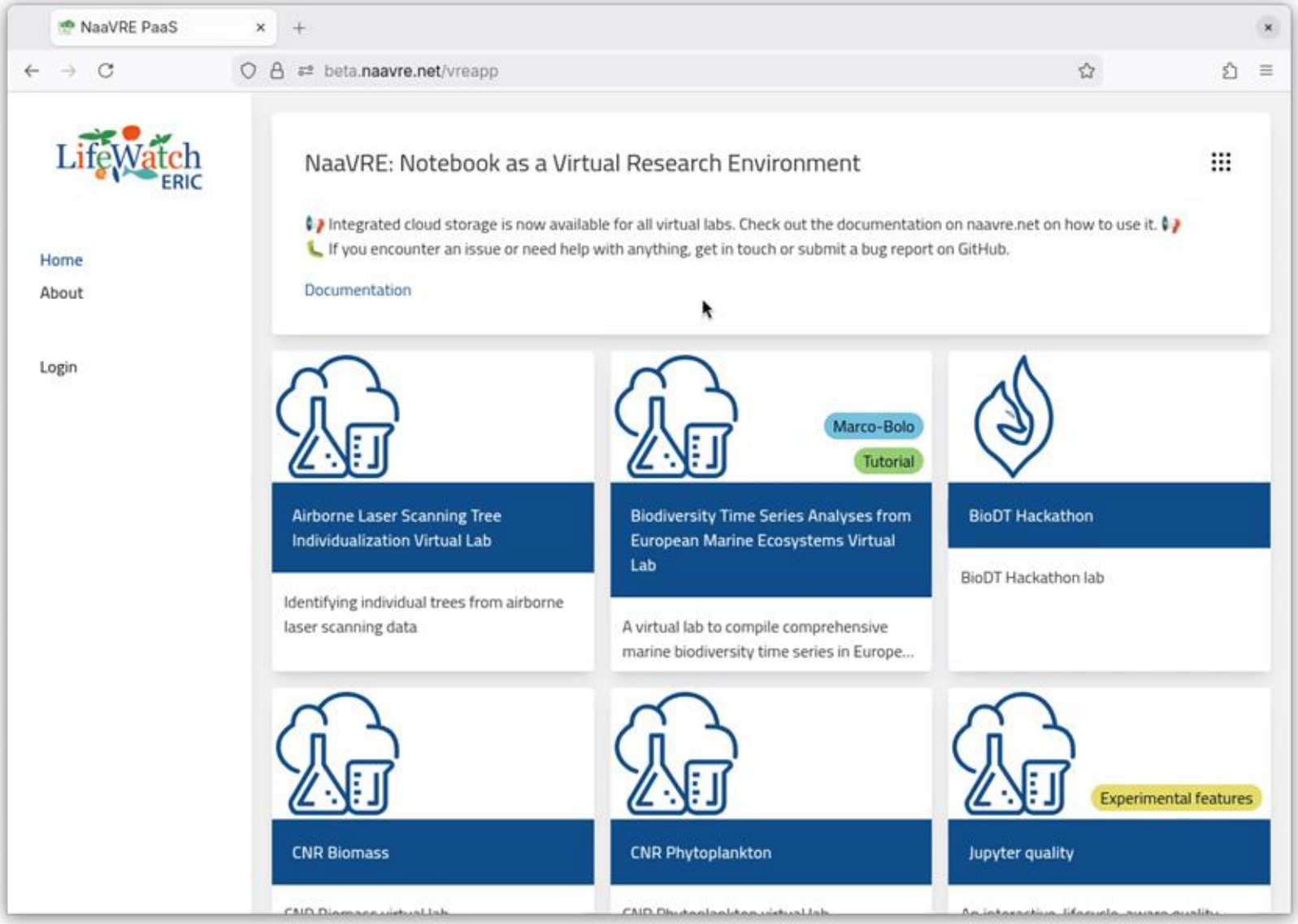
Workflow Results

Data storage

VRE assets catalogue

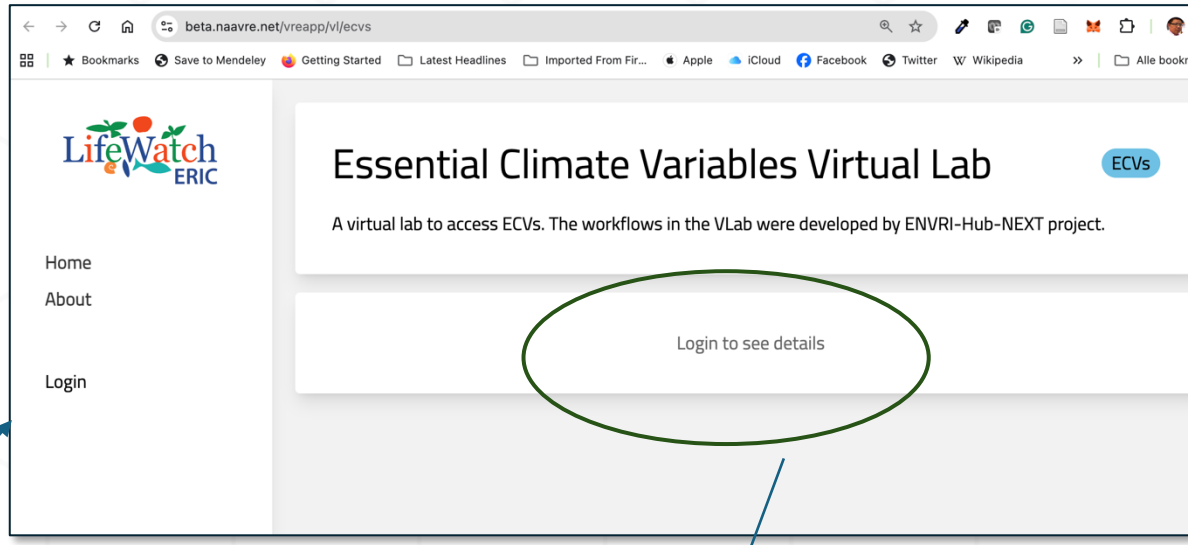
Notebook-as-a-VRE and Virtual Labs

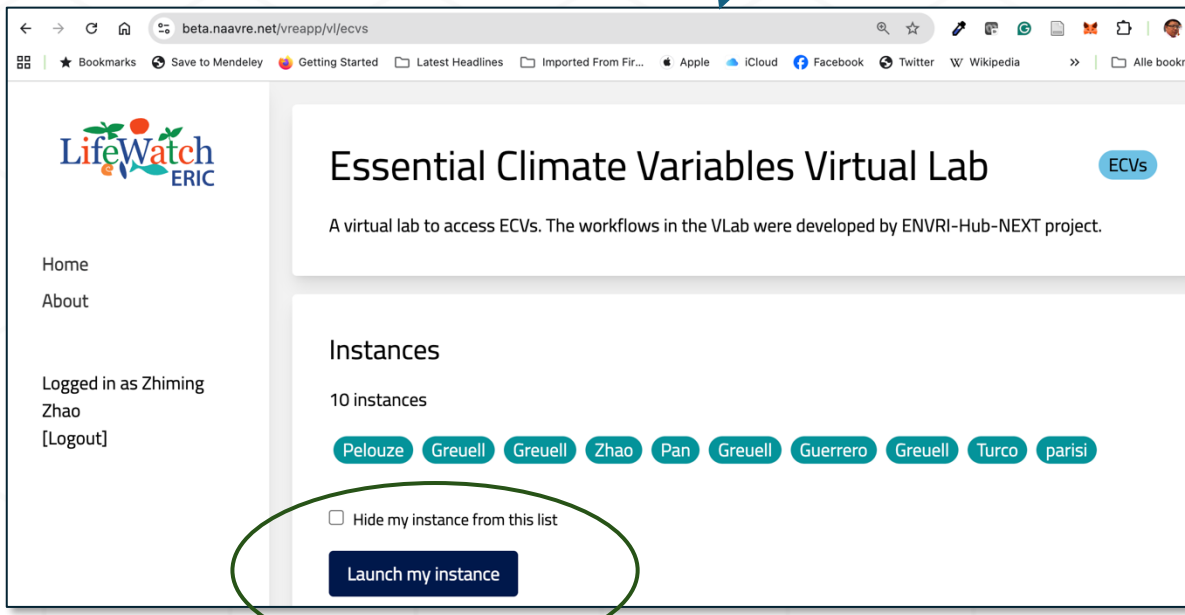




Steps

www.naavre.net





4. Hands on

Hands on

- *Try ENVRI-HUB and ENVRI Knowledgebase for ECV*
  - ***https://envri-hub.envri.eu/***
- Try ECV Virtual Lab
  - **https://naavre.net/**

How to access the Virtual Lab

https://naavre.net/

NaaVRE Documentation GitHub

Notebook as a Virtual Research Environment

Follow the tutorial | Open NaaVRE

Share digital assets with collaborators

In NaaVRE you can share source code, models, workflows and analysis results with your team and community.

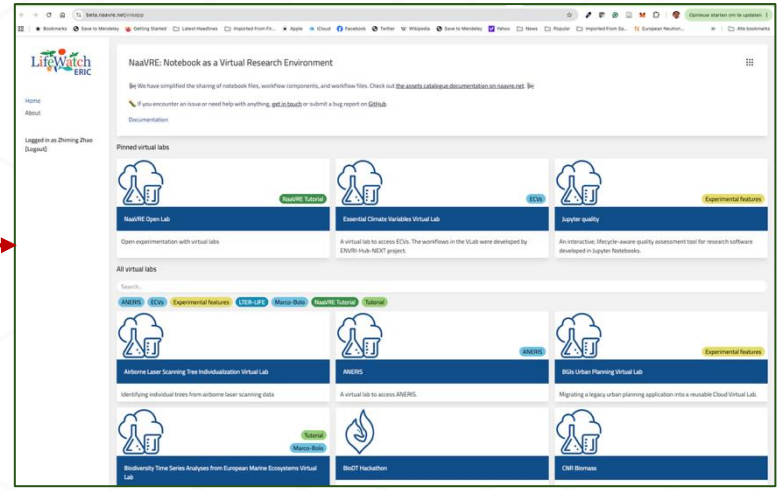
Turn source code from Jupyter notebooks into workflow components

NaaVRE lets you create workflow components from Jupyter notebook cells and use these components to build workflows.

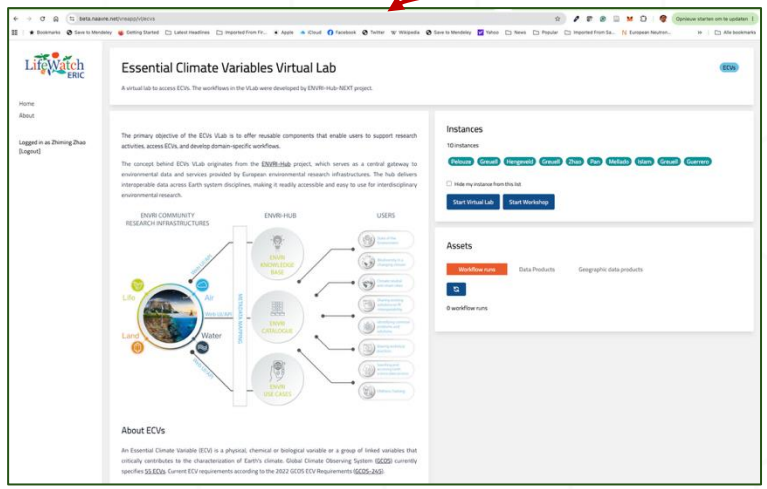
Run your workflows in the cloud

Execute workflows in a scalable cloud environment with configurable input and parameters.

NaaVRE (Notebook as a Virtual Research Environment) is a user-centric platform that supports the full research lifecycle through customizable Virtual Labs. It streamlines collaboration by providing unified access to data, models, and software, while removing the complexity of creating and executing research workflows on the cloud[12].



How to access the Virtual Lab



beta.naavre.net/vreapp

LifeWatch ERIC

Home
About

Logged in as Zhiming Zhao
[Logout]

NaaVRE: Notebook as a Virtual Research Environment

We have simplified the sharing of notebook files, workflow components, and workflow files. Check out the assets catalogue documentation on naavre.net.

If you encounter an issue or need help with anything, get in touch or submit a bug report on GitHub.

Pinned virtual labs

NaaVRE Open Lab — NaaVRE Tutorial
Open experimentation with virtual labs

Essential Climate Variables Virtual Lab — ECVs
A virtual lab to access ECVs. The workflows in the VLab were developed by ENVRI-Hub-NEXT project.

Jupyter quality — Experimental features
An interactive, lifecycle-aware quality assessment tool for research software developed in Jupyter Notebooks.

All virtual labs

Search...

ANERIS | ECVs | Experimental features | LTER-LIFE | Marco-Bolo | NaaVRE Tutorial | Tutorial

Airborne Laser Scanning Tree Individualization Virtual Lab
Identifying individual trees from airborne laser scanning data

ANERIS — ANERIS
A virtual lab to access ANERIS.

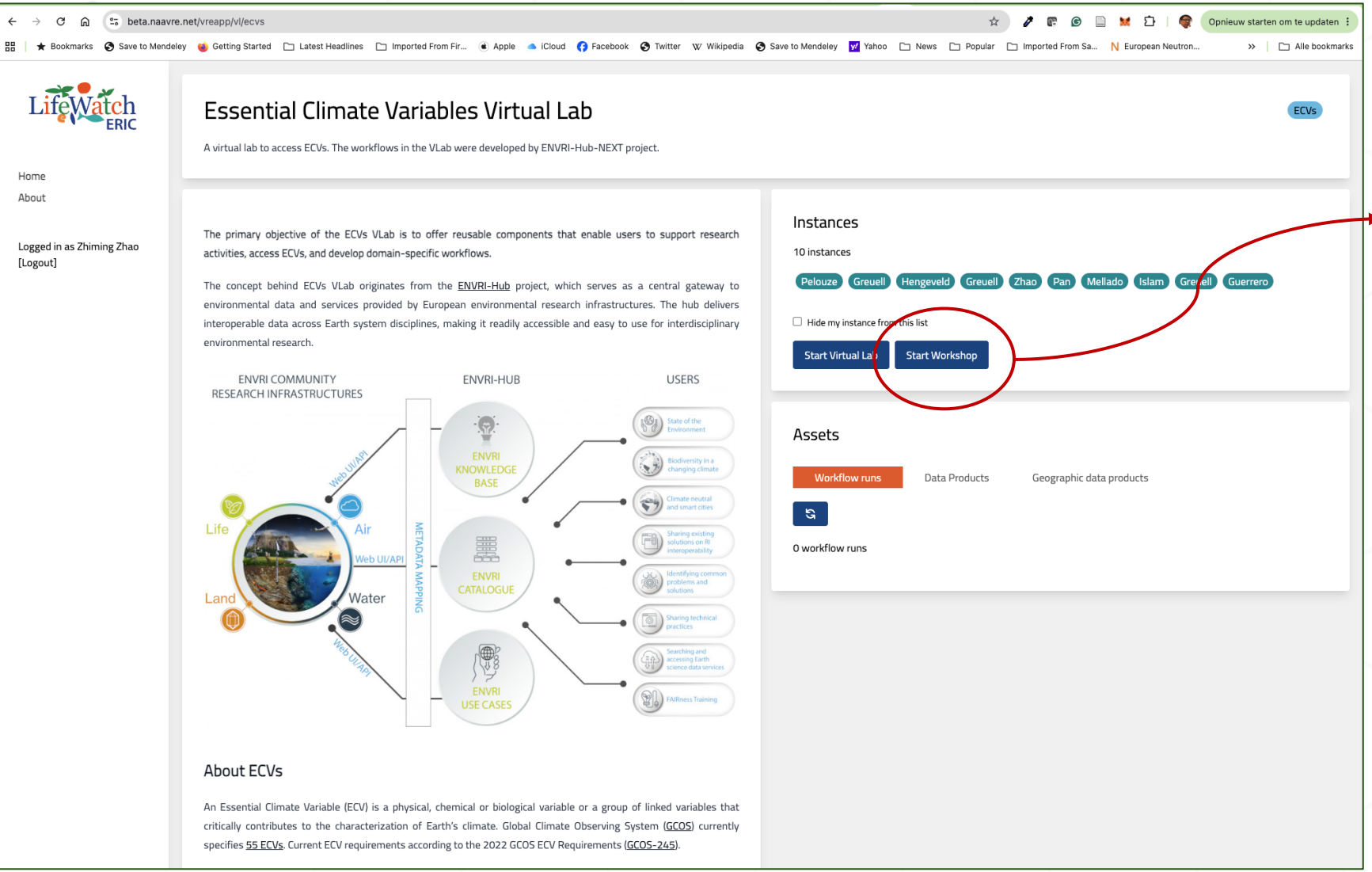
BGIs Urban Planning Virtual Lab — Experimental features
Migrating a legacy urban planning application into a reusable Cloud Virtual Lab.

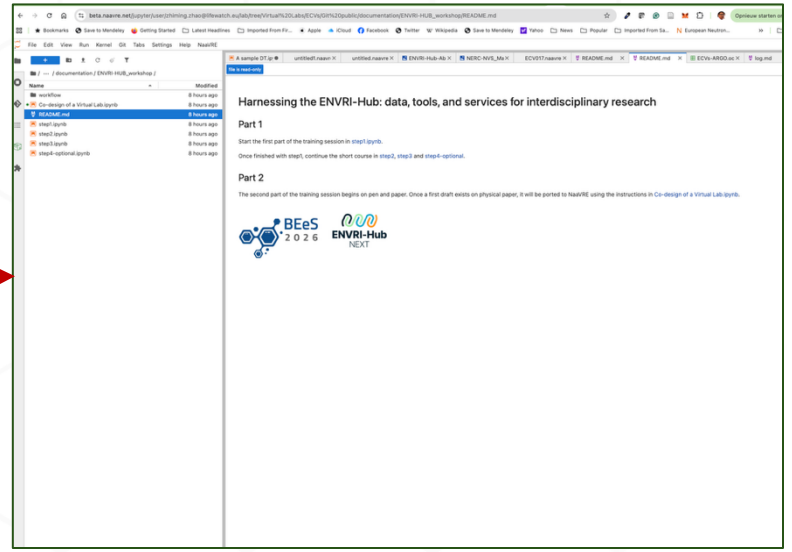
Biodiversity Time Series Analyses from European Marine Ecosystems Virtual Lab — Tutorial, Marco-Bolo

BioDT Hackathon

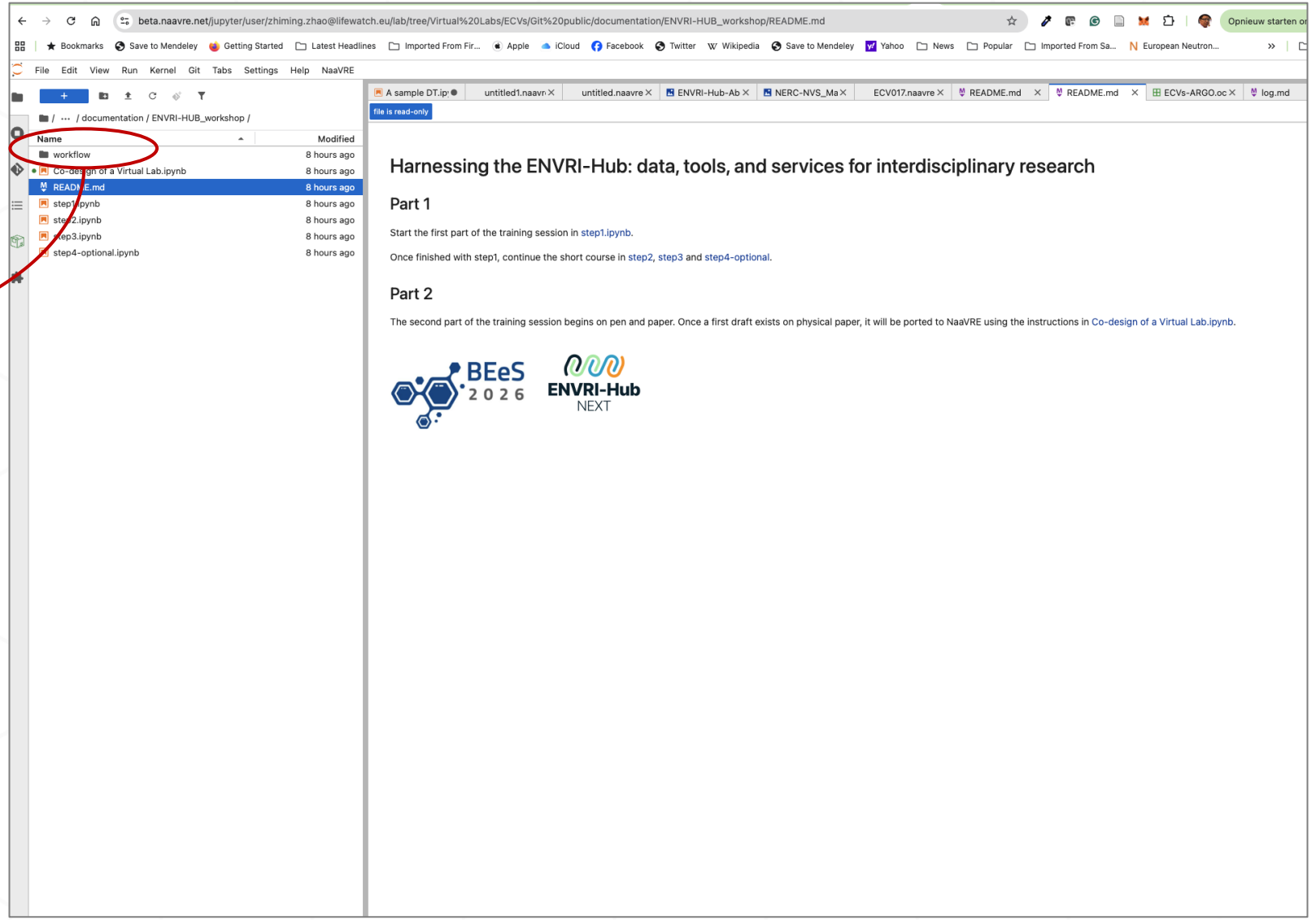
CNR Biomass

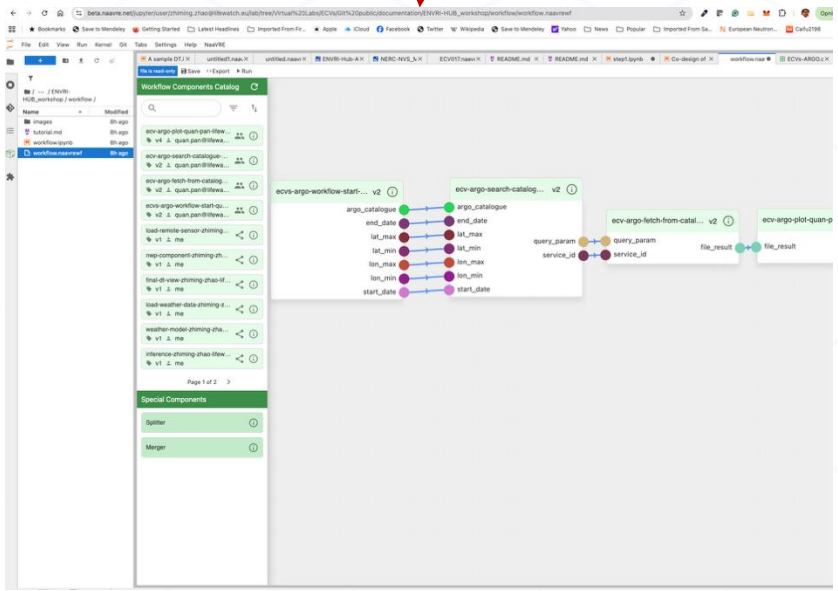
How to access the Virtual Lab





How to access the Virtual Lab





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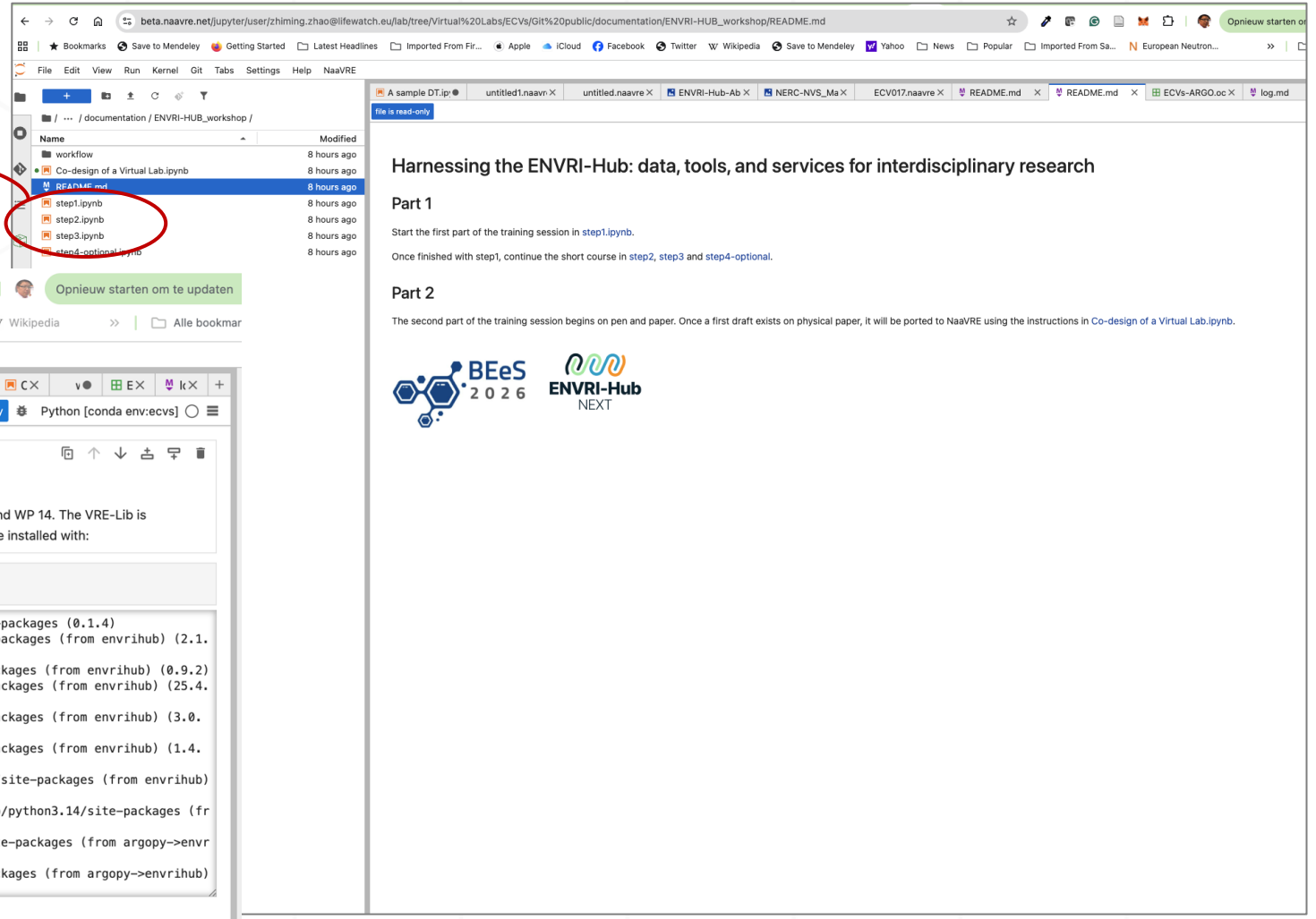

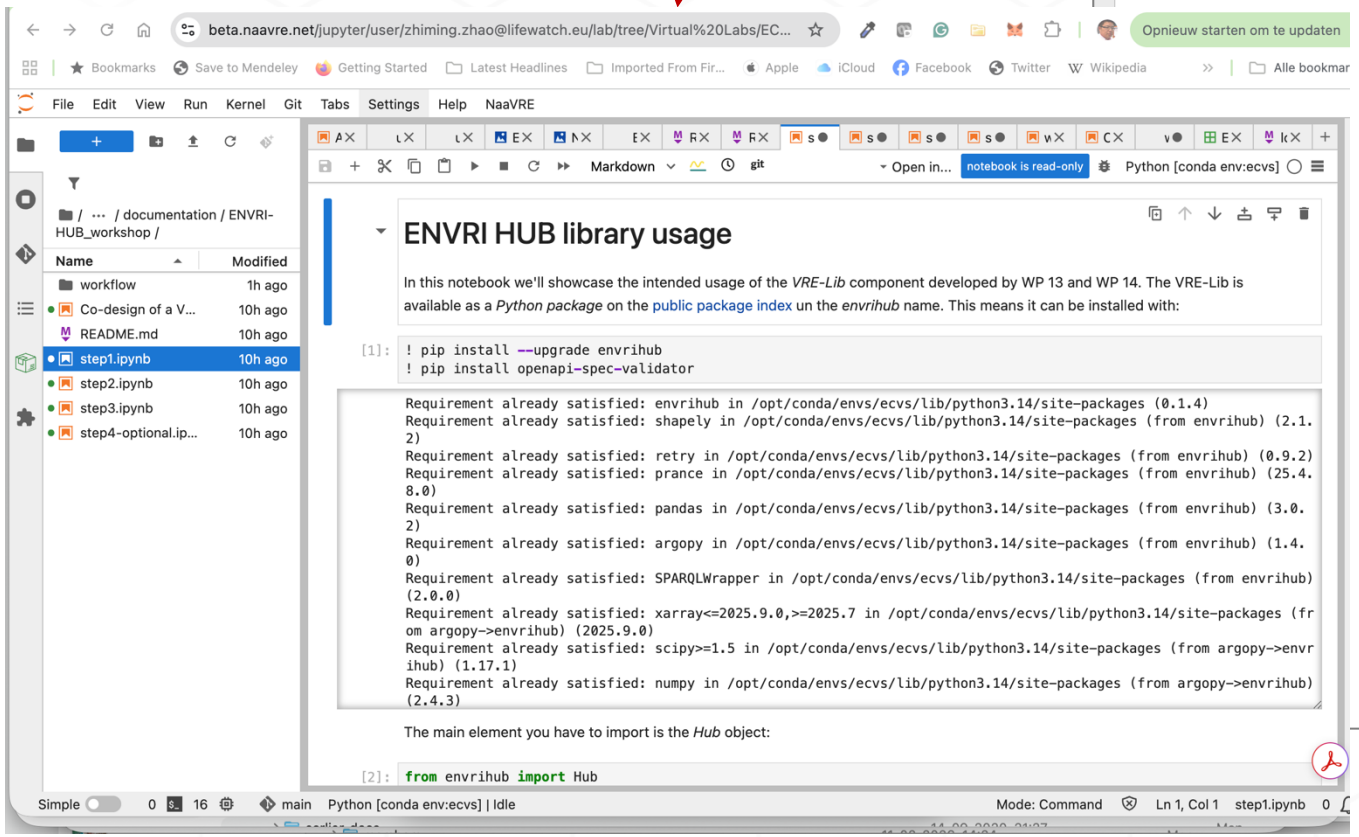

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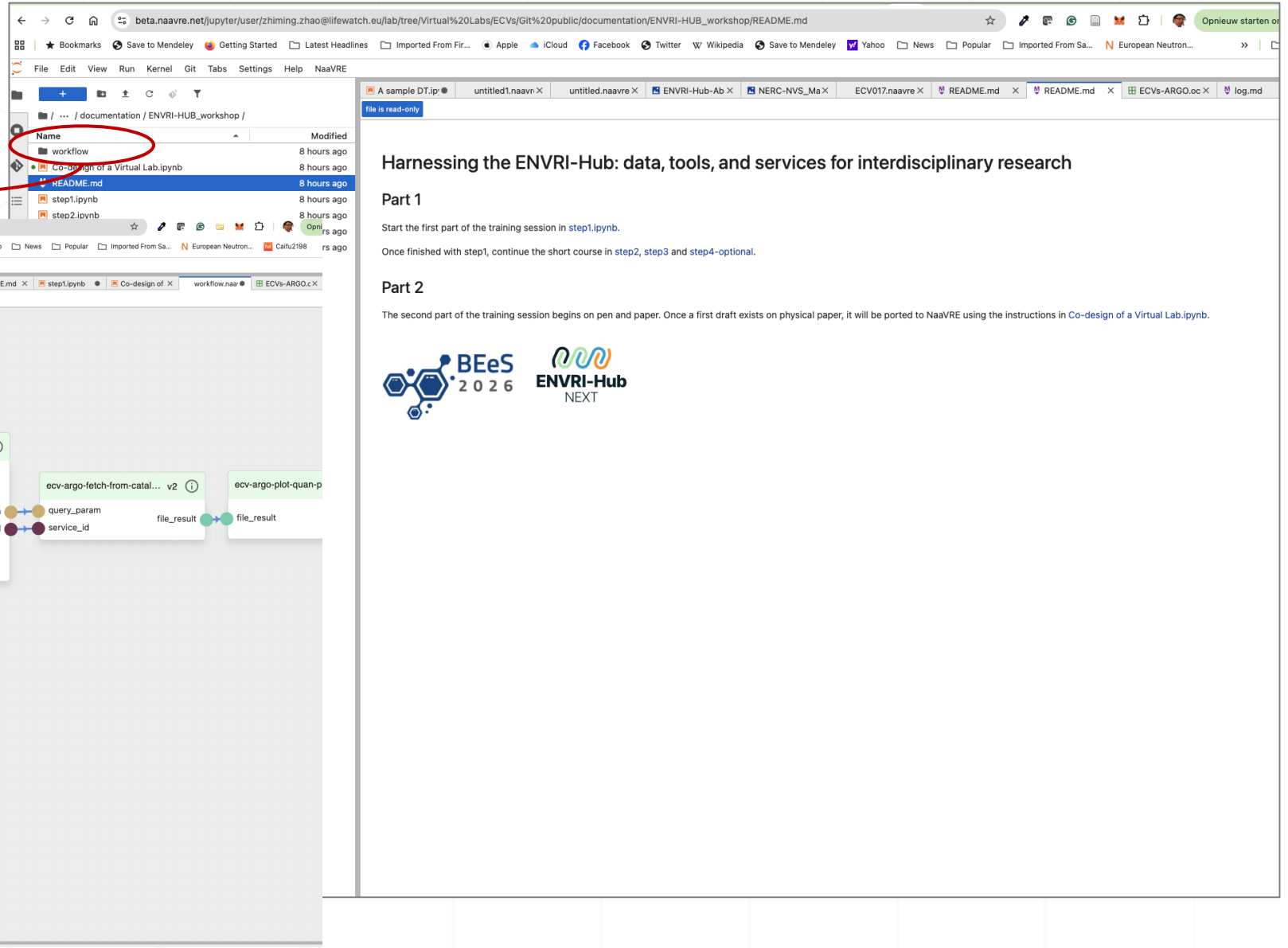

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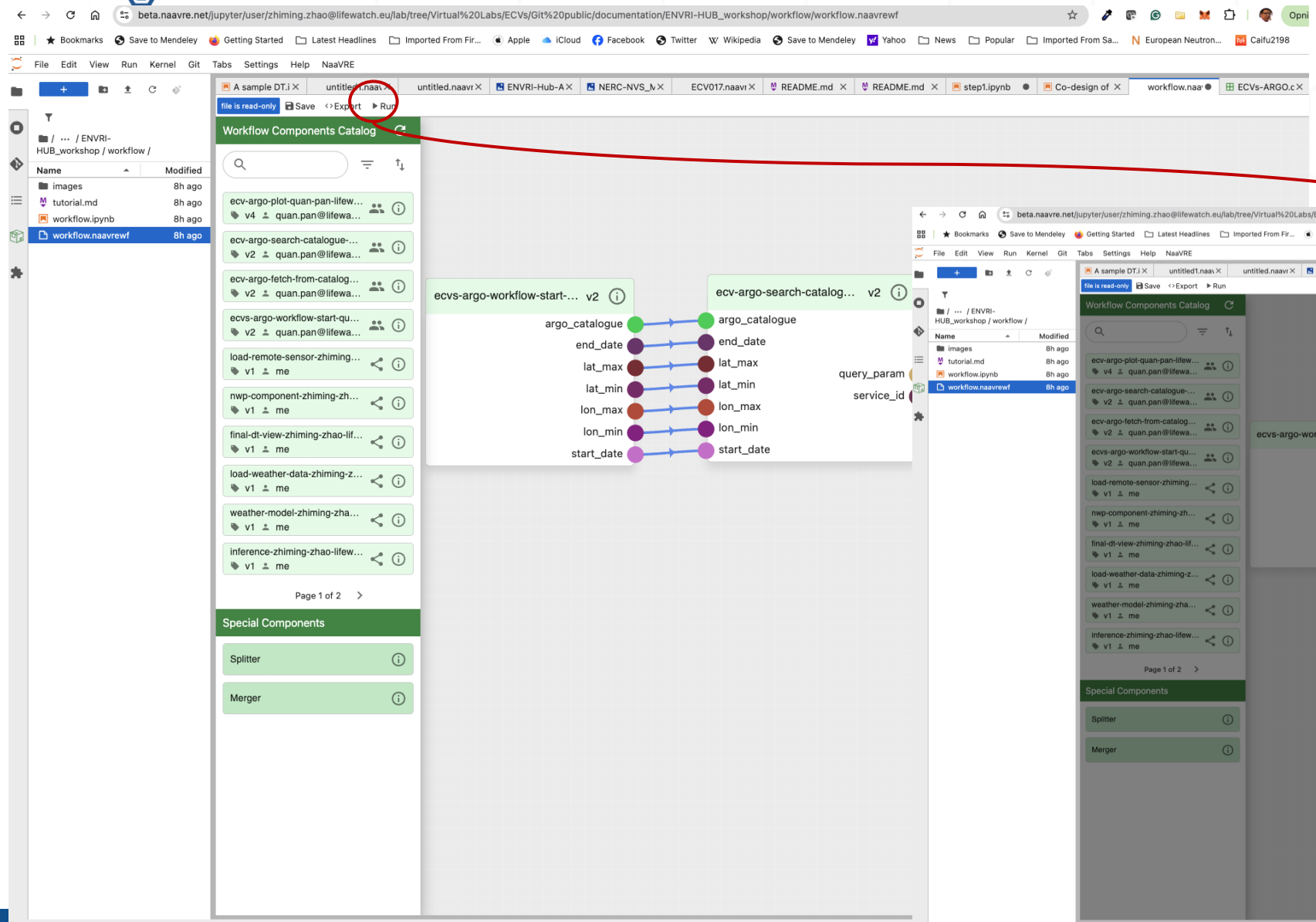

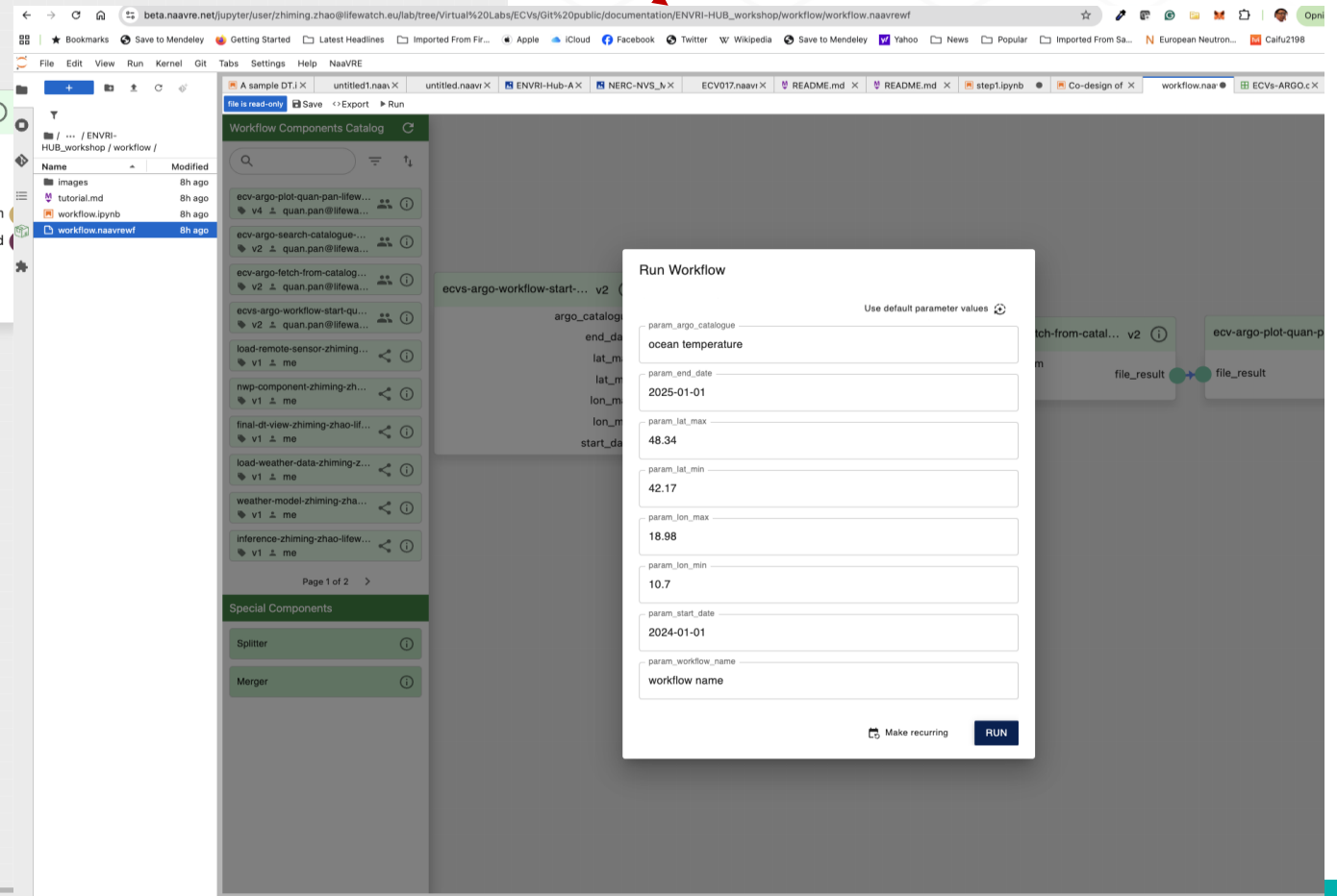

5. Feedback

Feedback

- **https://www.menti.com**
- Code: **7804 0981**

menti.com

7804 0981

BEeS 2026

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

PLOVDIV, BULGARIA 7-10 JULY 2026

THANK YOU!

Questions?

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Zhiming.zhao@lifewatch.eu

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Universiteit van Amsterdam

ENVRI-Hub NEXT