



The LifeWatch ERIC Biodiversity
& Ecosystem eScience Conference

PLOVDIV, BULGARIA

7-10 JULY 2026

ENVRI-Hub tools and VREs for researchers



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University of Amsterdam

LifeWatch ERIC - Virtual Lab & Innovation Center (VLIC)



UNIVERSITEIT
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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



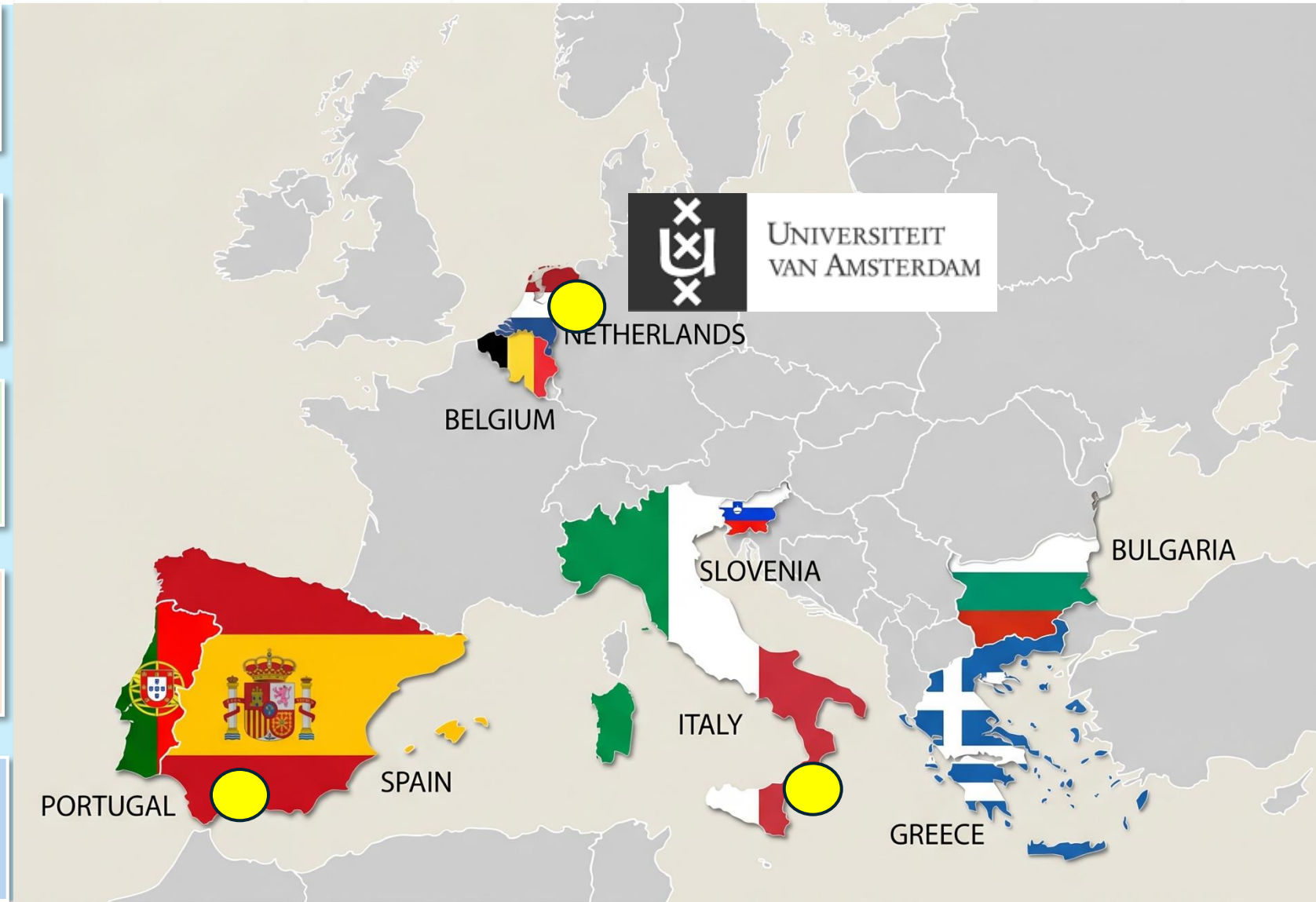
New research methods

- Digital Twins
- AI
- ...

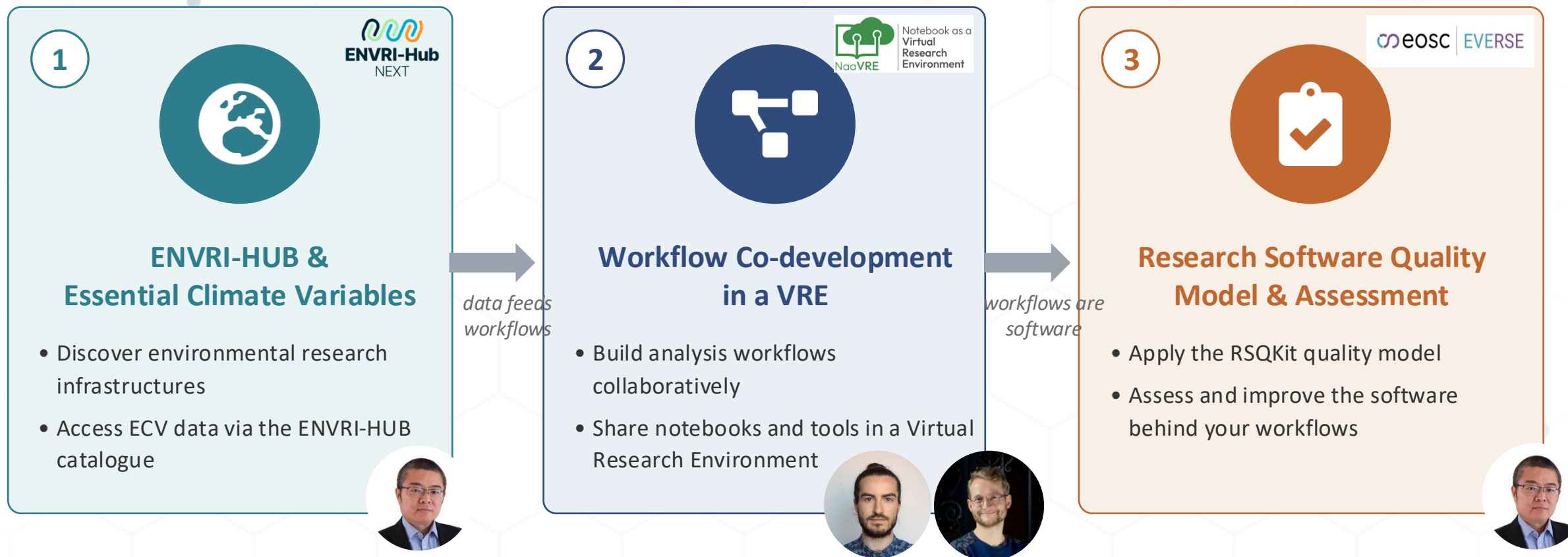


Community

- Training
- Support



Three Training Sessions: From Data to Quality Software



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

Zhiming Zhao

University of Amsterdam

LifeWatch ERIC - Virtual Lab & Innovation Center (VLIC)

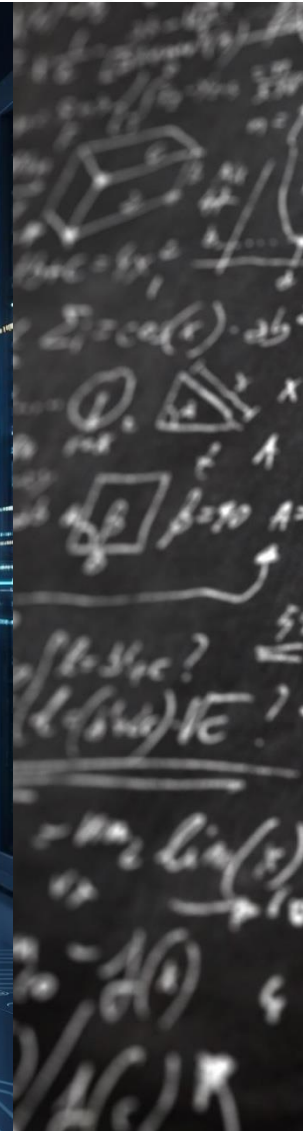
July 2026



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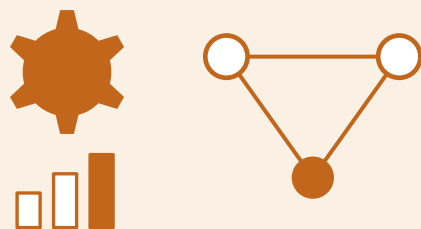


Computing technologies and scientific research



Infrastructures Supporting Scientific Research

3



eScience tools (research Infrastructures)

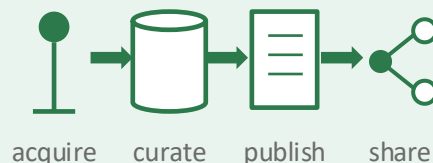
Science-ready resources for analysis and collaboration

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

e.g. **LifeWatch ERIC**



2

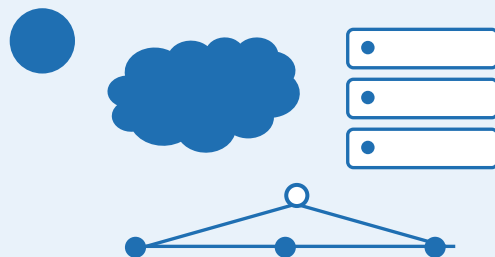


Data assets (data/research infrastructures)

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

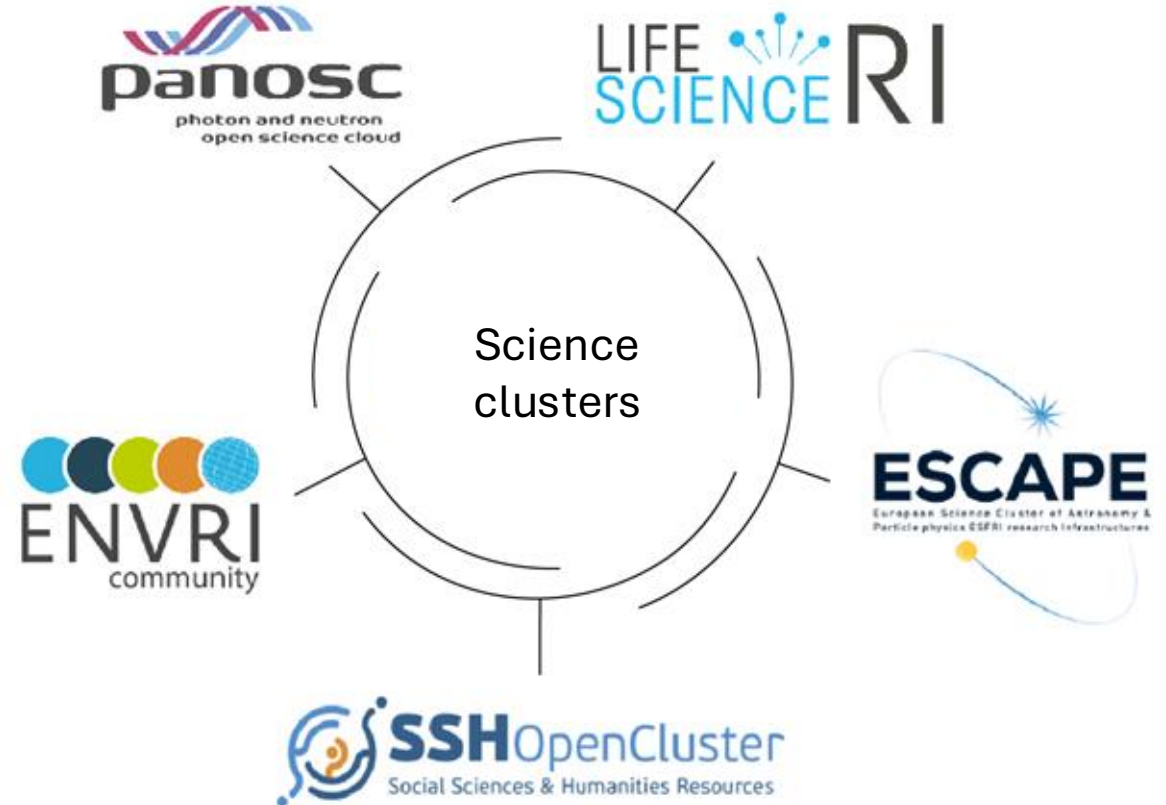
Cloud, HTC & HPC computing · scalable, federated storage · high-speed connectivity & AAI

e.g. **EGI, EUDAT, GÉANT**



Infrastructures in scientific communities

- LifeScience
- Social science and Humanities
- 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

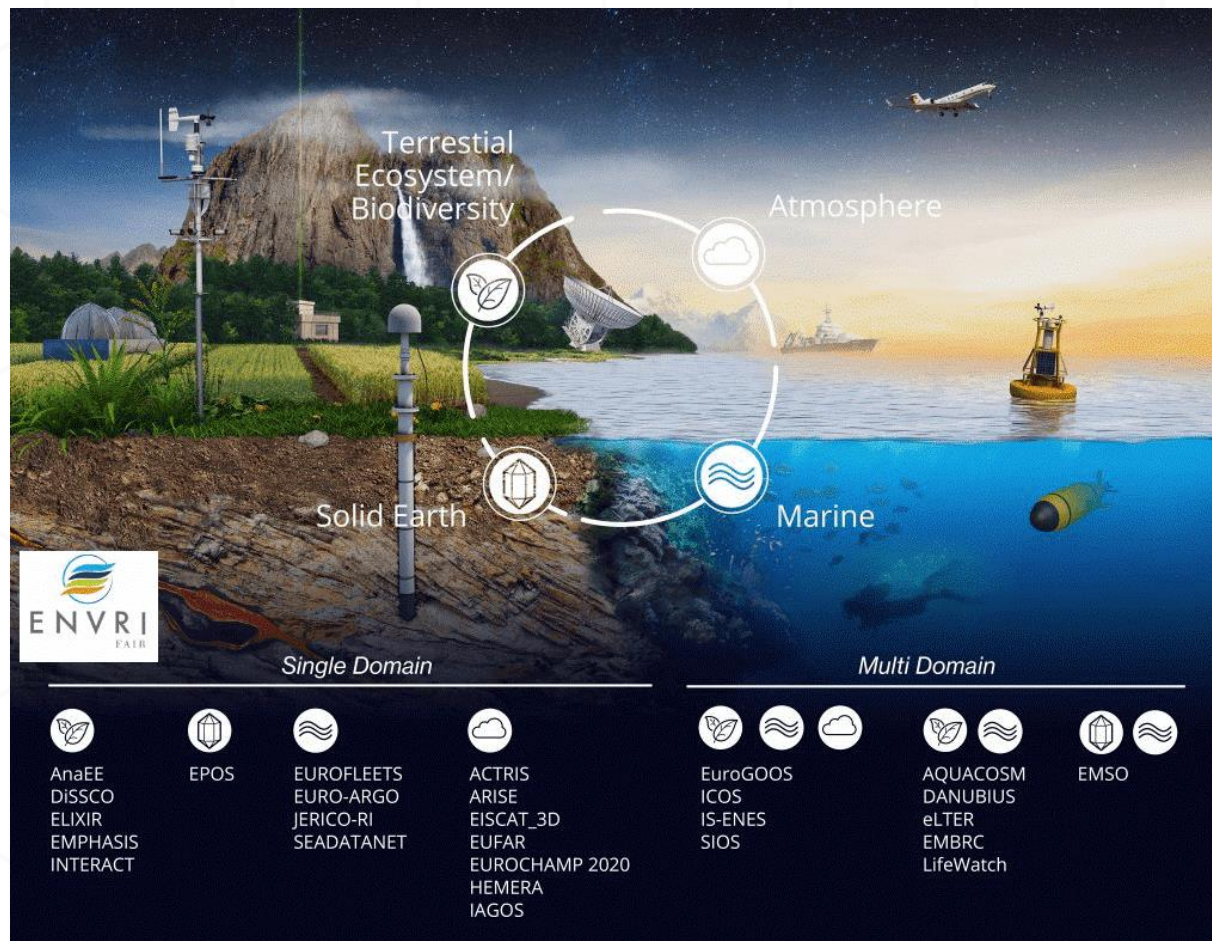
Outline

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

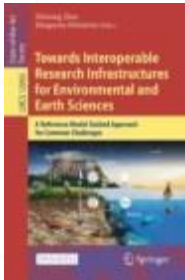


ENVRI
2011.11-2014.10

ENVRI-plus
2015.3-2019.2

ENVRI-FAIR
2019.3-2023.6

ENVRI-Hub NEXT
2024.2-2027.1



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



ENVRI Resources ▾

FAQ

About

Feedback

ENVRI Community

Login

Welcome to the Data Access and Services Hub of the European Environmental Research Infrastructures

The Competence Center for the ENVRI Community

Search within the ENVRI-Hub website content:



Catalogue of Services

Explore the Research Infrastructures services that provide access to data, metadata, semantic assets, taxonomic information and more, and visualise them on a world map.



Knowledge Base

Search the environmental research infrastructures web-exposed information (web pages, datasets, library and notebooks, web APIs and more).



Training Gateway

Access training resources developed by and for the ENVRI Community.



Catalogue of Data

The ENVRI FAIR Data Point Catalogue.



AI Environmental Expert

Search the environmental research infrastructures web-exposed information (web pages, datasets, library and notebooks, web APIs and more) in a natural language.



Programmatic access to the ENVRI-Hub services

Access the ENVRI-Hub services Applicable Programming Interfaces (APIs) and libraries.



ENVRI Innovation Hub (EIH)

The central platform for driving Innovation in environmental research infrastructures



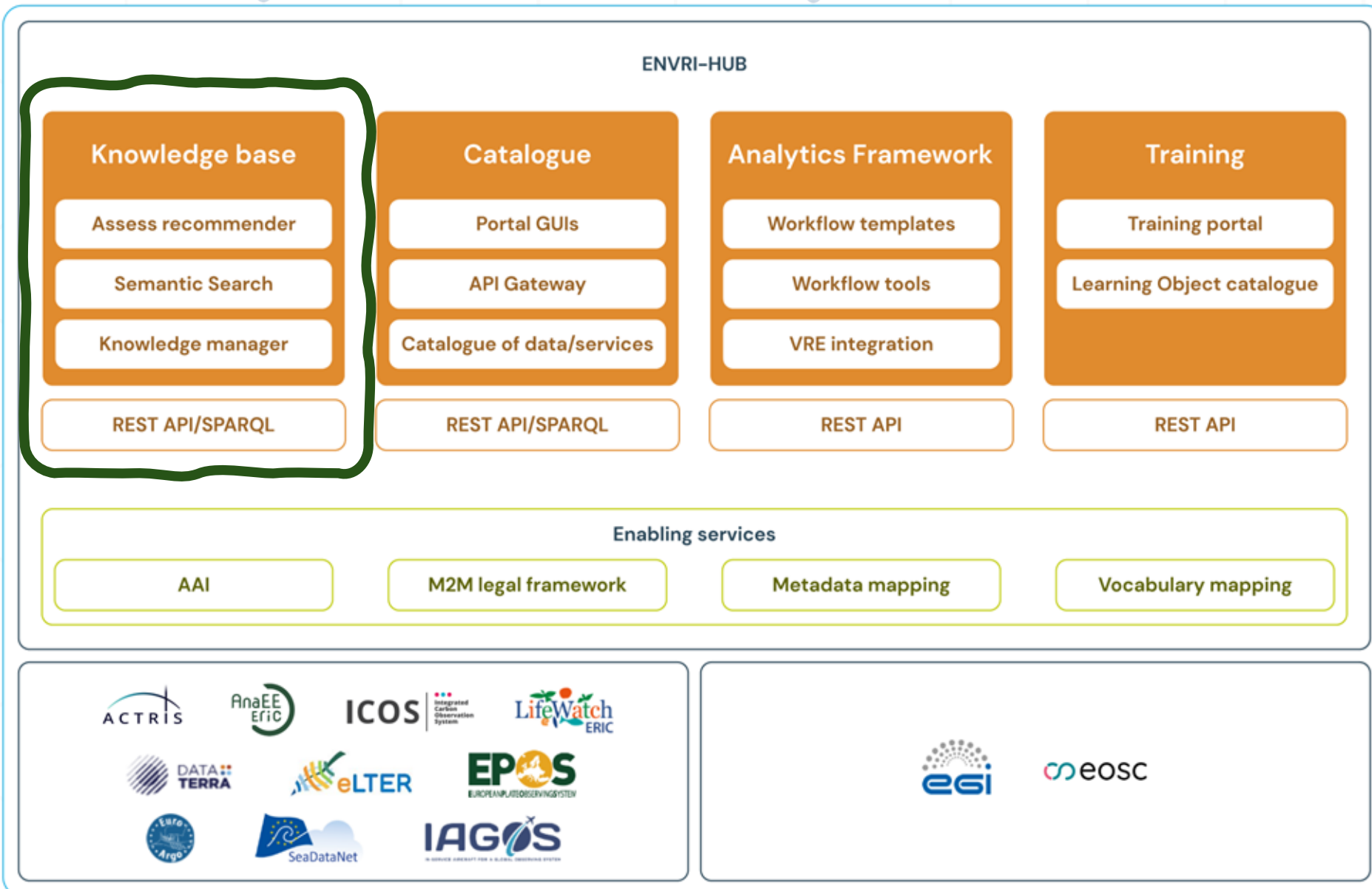
Science Demonstrators

Access to science demonstrators from the ENVRI community: interactive web services, example notebooks, and more.

Featured Science Demonstrators

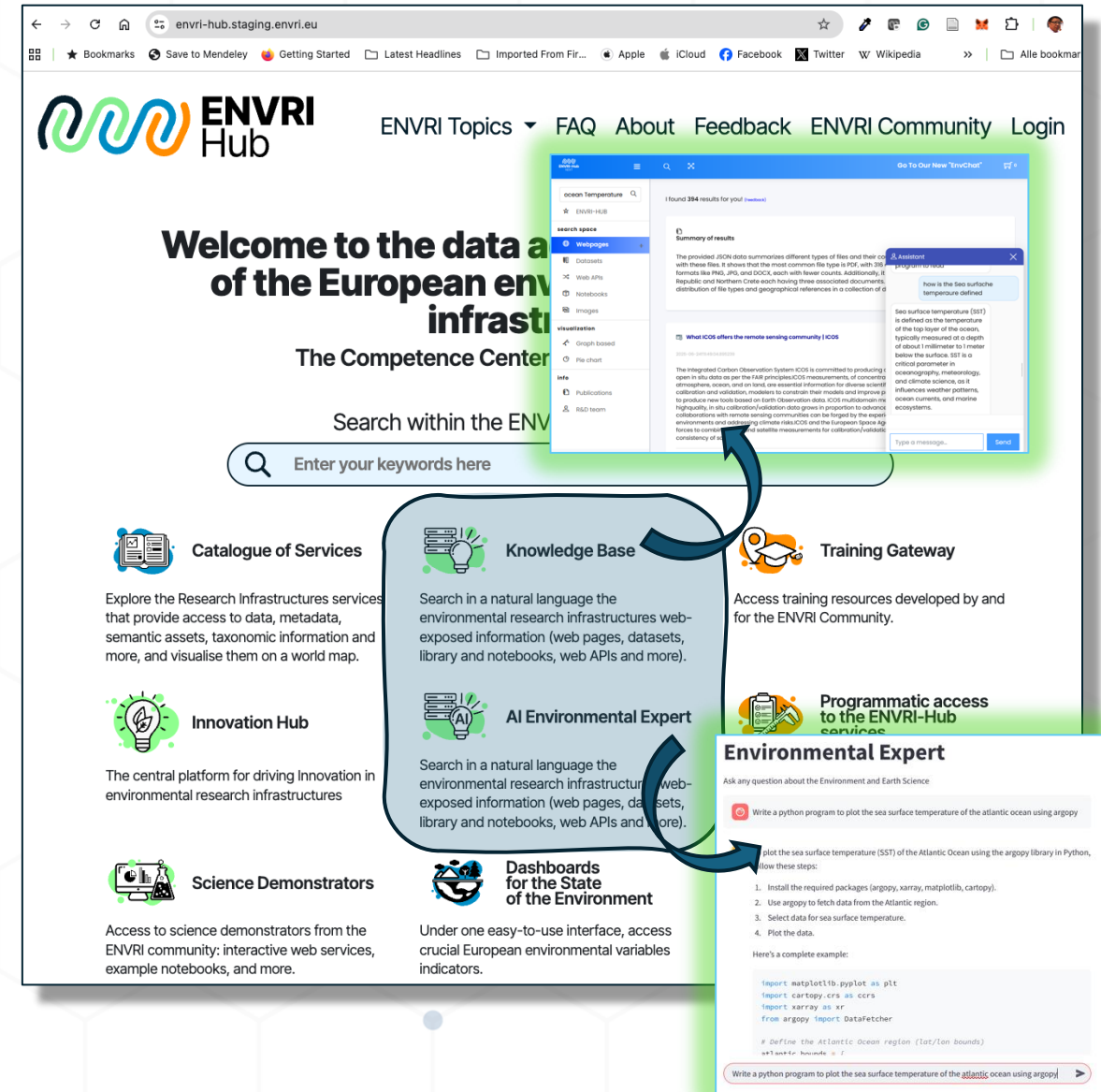


Architecture of ENVRI-HUB



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.



The screenshot displays the ENVRI Hub website interface. At the top, the ENVRI Hub logo is visible alongside navigation links: ENVRI Topics, FAQ, About, Feedback, ENVRI Community, and Login. A search bar is prominently featured with the text "Search within the ENVRI Hub" and a placeholder "Enter your keywords here".

Below the search bar, the "Knowledge Base" section is highlighted. It describes the service as a natural language search tool for environmental research infrastructures' web-exposed information, including web pages, datasets, libraries, notebooks, web APIs, and more. A diagram illustrates the integration of the Knowledge Base with other services: Catalogue of Services, Innovation Hub, Science Demonstrators, Training Gateway, Programmatic access to the ENVRI-Hub services, and Dashboards for the State of the Environment.

An inset window shows a search results page for "ocean temperature". It displays a "Summary of results" and a "How is the sea surface temperature defined?" section. The summary states that the provided ICOS data summarizes different types of files and their counts, with the most common file type being PDF. The definition section explains that sea surface temperature (SST) is the temperature of the top layer of the ocean, typically measured at a depth of about 1 millimeter to 1 meter below the surface. SST is a critical parameter in oceanography, meteorology, and climate science, as it influences weather patterns, ocean currents, and marine ecosystems.

At the bottom, the "Environmental Expert" section is shown, featuring a text input field with the prompt "Write a python program to plot the sea surface temperature of the atlantic ocean using argopy". Below the input, a list of steps is provided: 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. A code snippet is also displayed, showing the necessary imports and the definition of the Atlantic Ocean region.



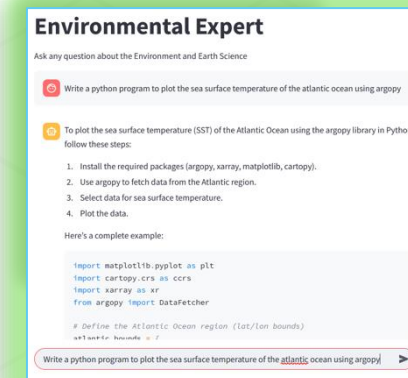
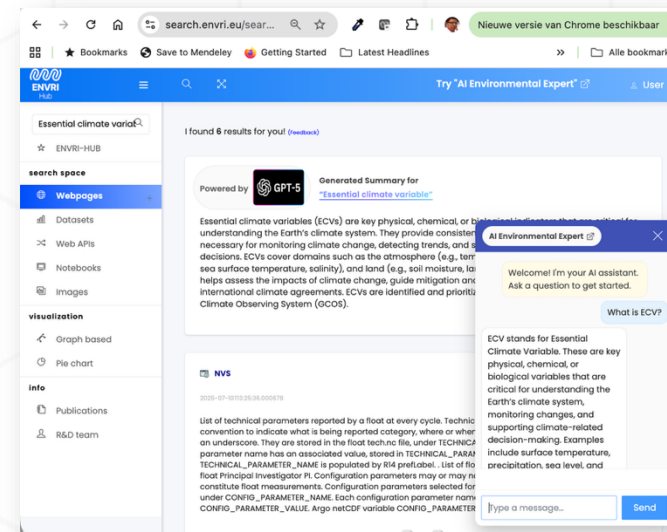
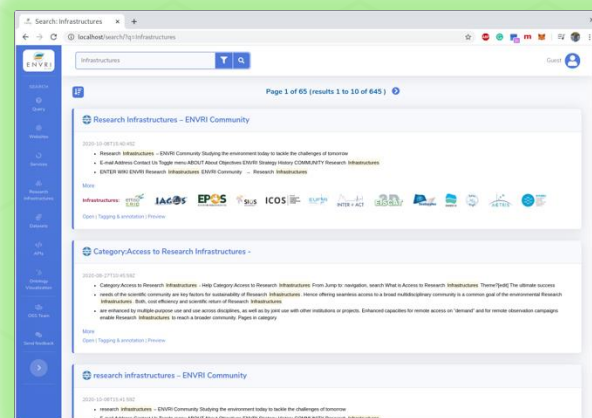
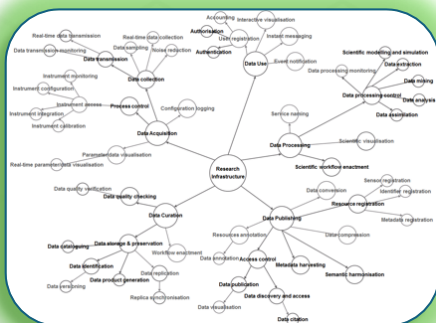
ENVRI Knowledge Base: A Short History



ENVRI-plus, 2015.3-2019.2

ENVRI FAIR 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

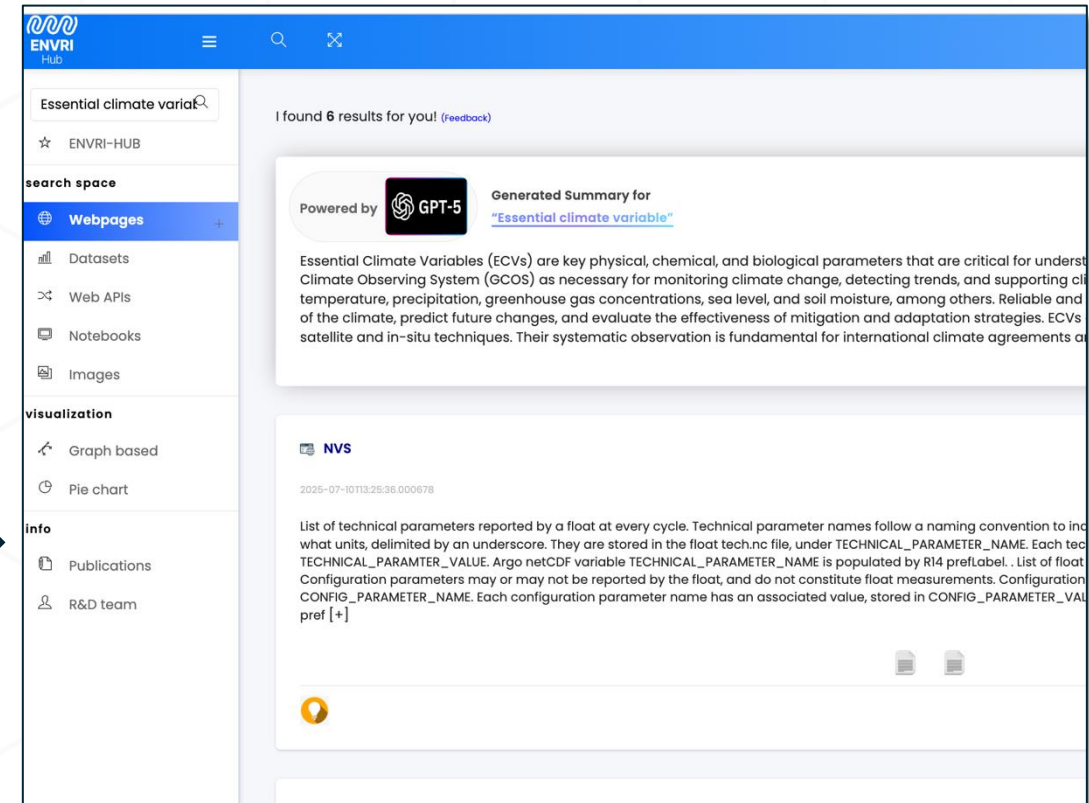
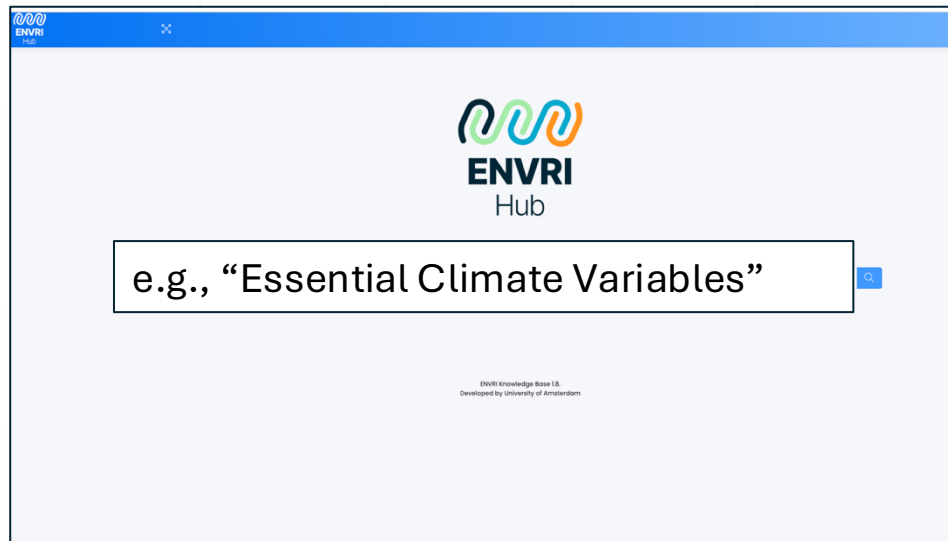


User: Dialogue enhanced Knowledge discovery

Knowledge Base Features: Free text search



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



Knowledge Base Features: Free text search

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

Essential climate variables

ENVRI-HUB

search space

- Webpages
- Datasets**
- Web APIs
- Notebooks
- Images

visualization

- Graph based
- Pie chart

info

- Publications
- R&D team

VARIABILITY OF THE CO2 PARTIAL PRESSURE IN THE UPPER OCEAN.

CO2 partial pressure in the upper ocean on transects across Atlantic and Pacific Oceans (1991 onwards)

PHYS., CHEM. OCEAN. DATA CONFLUENCE PROG. (SW ATLANTIC OC.)

Measurements in the area of the confluence of Brazil and Malvinas currents (SW Atlantic Ocean) of the thermocline, front dynamics. The programme is divided into 3 phases: Pilot phase (1988-91), intensive cooperation between 3 institute [+]: LOCEAN (Univ. Paris 6-France), LDGO (Univ. Columbia-USA) and during the pilot phase, on board of Argentinian and French ships. The corresponding data set includes been responsible for the validation of the data sets collected with its own instruments. The CTD and current according to the usual LOCEAN procedures: calibration of pressure, temperature, current at the IFREMER samples taken at sea. Processing of the data with the LOCEAN software. Three cruises have been carried

GEOCHEMISTRY PHYTOPLANKTON AND COLOR OF THE OCEAN (GeP&CO)

GeP&CO, action of the french programme PROOF, aims at describing and understanding the phytoplankton

SeaDataNet

PAN-EUROPEAN INFRASTRUCTURE FOR OCEAN & MARINE DATA MANAGEMENT

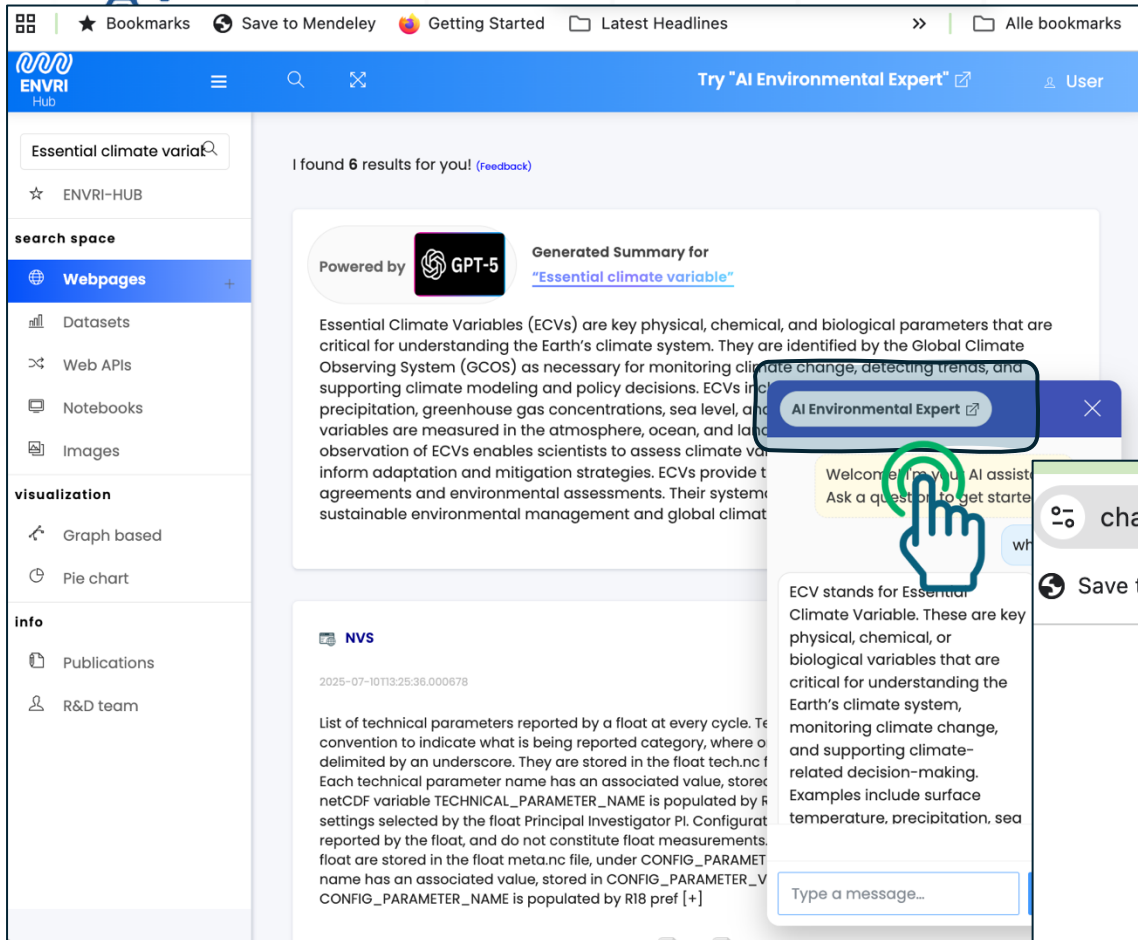
EUROPEAN ENVIRONMENTAL AGENCY

DATA SET INFORMATION

GENERAL	
Data set name	PHYS., CHEM. OCEAN. DATA CONFLUENCE PROG. (SW ATLANTIC O)
Data holding centre	Laboratory of Oceanography and Climate, Experiments and numerical Approaches
Country	France 
Time period	1988 to 2003
Ongoing	No
Geographical area	Argentinian basin
OBSERVATIONS	
Parameters	Sea level; Dissolved oxygen parameters in the water column; Bathymetry and Elevation; Nutrient sediment pore waters; Partial pressure (pCO2) and fugacity (fCO2) of carbon dioxide in the water column; dissolved inorganic carbon (TCO2) concentration in the water column; Skin temperature of the water column; temperature and/or salinity instrument output; Horizontal velocity of the water column (current)
Instruments	Inverted echosounders; current profilers; discrete water samplers; cameras; CTD; current meter

[illegible][illegible]

KB Features: Environmental Expert



ENVRI Hub

Essential climate variable

I found 6 results for you! (Feedback)

Powered by  Generated Summary for "Essential climate variable"

Essential Climate Variables (ECVs) are key physical, chemical, and biological parameters that are critical for understanding the Earth's climate system. They are identified by the Global Climate Observing System (GCOS) as necessary for monitoring climate change, detecting trends, and supporting climate modeling and policy decisions. ECVs include precipitation, greenhouse gas concentrations, sea level, and land use. ECVs are measured in the atmosphere, ocean, and land. Observation of ECVs enables scientists to assess climate change, inform adaptation and mitigation strategies. ECVs provide the basis for climate agreements and environmental assessments. Their systematic observation and sustainable environmental management and global climate

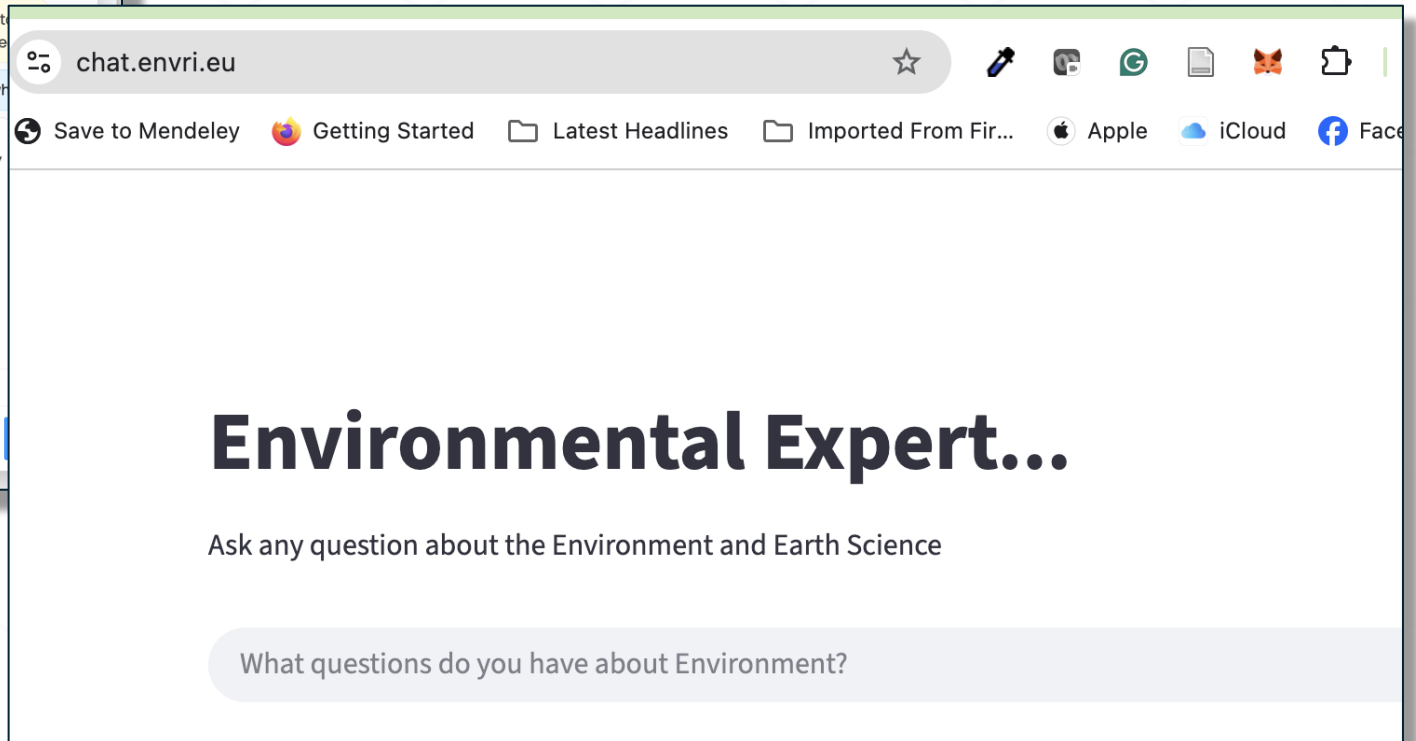
AI Environmental Expert

ECV stands for Essential Climate Variable. These are key physical, chemical, or biological variables that are critical for understanding the Earth's climate system, monitoring climate change, and supporting climate-related decision-making. Examples include surface temperature, precipitation, sea

info

Publications

R&D team



chat.envri.eu

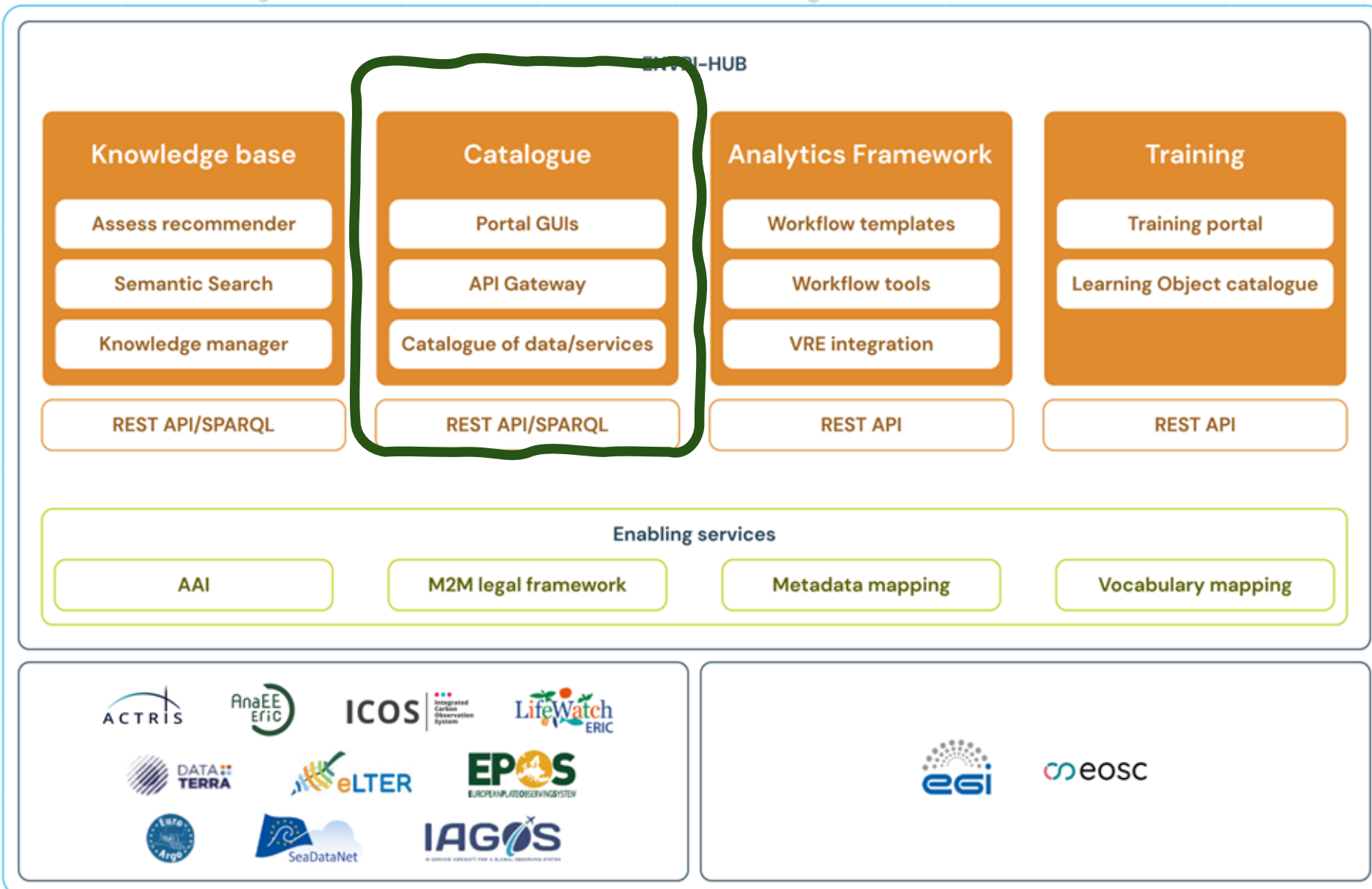
Save to Mendeley Getting Started Latest Headlines Imported From Fir... Apple iCloud Facebook

Environmental Expert...

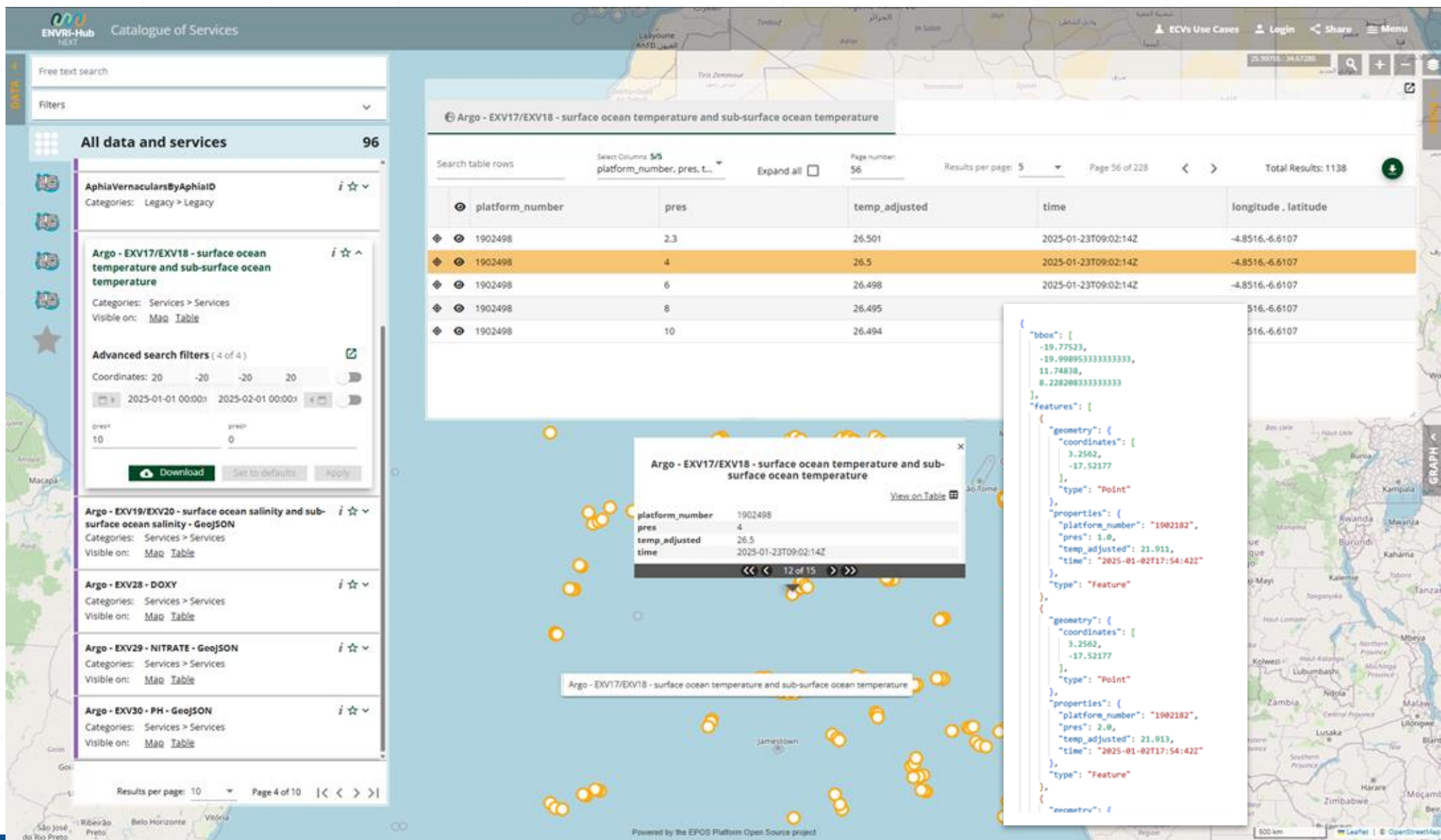
Ask any question about the Environment and Earth Science

What questions do you have about Environment?

Architecture of ENVRI-HUB



ENVRI Catalogue of Services

The screenshot displays the ENVRI Catalogue of Services user interface. The left sidebar shows a list of services, including "Argo - EXV17/EXV18 - surface ocean temperature and sub-surface ocean temperature". The main area shows a table of data for this service, with columns for platform_number, pres, temp_adjusted, time, and longitude, latitude. A map view is also visible, showing the location of the data points in the Atlantic Ocean. A detailed view of a specific data point is shown, including its coordinates and properties.

Argo - EXV17/EXV18 - surface ocean temperature and sub-surface ocean temperature

platform_number	pres	temp_adjusted	time	longitude, latitude
1902498	2.3	26.501	2025-01-23T09:02:14Z	-4.8516, -6.6107
1902498	4	26.5	2025-01-23T09:02:14Z	-4.8516, -6.6107
1902498	6	26.498	2025-01-23T09:02:14Z	-4.8516, -6.6107
1902498	8	26.495	2025-01-23T09:02:14Z	-4.8516, -6.6107
1902498	10	26.494	2025-01-23T09:02:14Z	-4.8516, -6.6107

Argo - EXV17/EXV18 - surface ocean temperature and sub-surface ocean temperature

platform_number: 1902498
pres: 4
temp_adjusted: 26.5
time: 2025-01-23T09:02:14Z

```

{
  "bbox": [
    -19.77523,
    -19.998953333333333,
    11.74838,
    8.228283333333333
  ],
  "features": [
    {
      "geometry": {
        "coordinates": [
          3.2562,
          -17.52177
        ],
        "type": "Point"
      },
      "properties": {
        "platform_number": "1902182",
        "pres": 1.0,
        "temp_adjusted": 21.913,
        "time": "2025-01-02T17:54:42Z"
      },
      "type": "Feature"
    },
    {
      "geometry": {
        "coordinates": [
          3.2562,
          -17.52177
        ],
        "type": "Point"
      },
      "properties": {
        "platform_number": "1902182",
        "pres": 2.0,
        "temp_adjusted": 21.913,
        "time": "2025-01-02T17:54:42Z"
      },
      "type": "Feature"
    }
  ],
  "spacetrans": 1
}

```

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

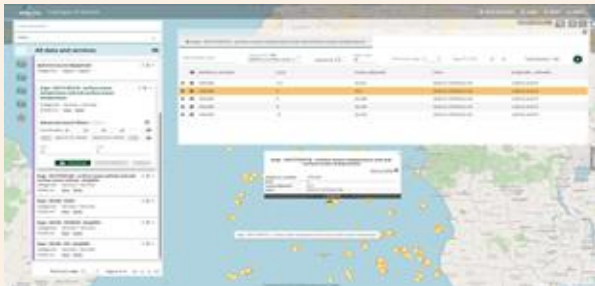
variable

location

time

provider

access



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.



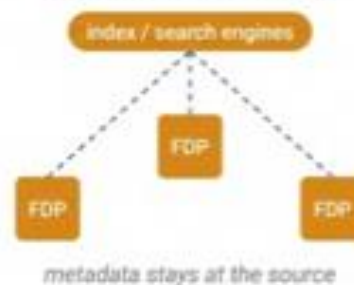
ENVRI Catalogue of Data (FDP)



FAIR Data Point REST API + web GUI



decentralised network



ENVRI Catalogue of Data

The tab "Data catalogs" lists catalogs of datasets and collections of datasets made available by some of the research infrastructures (RIs) that are part of ENVRI. The tab "Variables" contains the definition of variables included in the datasets listed under "Data catalogs". The definitions use the I-ADOPT vocabulary and link to external controlled vocabularies. The tab "Data services" lists services provided by some of the RIs that are part of ENVRI.

Data catalogs Variables Data services

Data catalogs

+ Create

ACTRIS data

ACTRIS data products catalog

Issued 24-11-2024 Modified 24-11-2024

Argo marine data

All data collected by Argo floats

InSitu Ocean 720a52b0-e991-4b0c-b2d1-c6863918186d

Issued 25-11-2024 Modified 20-12-2024

EPOS Sea level

18 21 f41aade-0dab-42d2-9713-d68e972263f4

Issued 10-12-2024 Modified 10-07-2025

ICOS data

ICOS data products catalog

6a43782b-13da-40a0-a65c-63480a940231 9150a404-40eb-41ae-b835-4077b989713f
c0b74231-0790-469b-9886-f8ff15eed5b atmosphere
8b61fc50-1c1d-4c58-8934-7e3d236b7ef7 ecosystem

Issued 24-11-2024 Modified 31-01-2025

Conforms to

• [FAIR Data Point Profile](#)

Metadata modified
10-07-2025

Metadata issued
24-11-2024

Endpoint description
ENVRI FDP Demo

Endpoint url
[ENVRI Catalogue of Data](#)

Version
1.0

Language
English

License
cc0

Rights
public

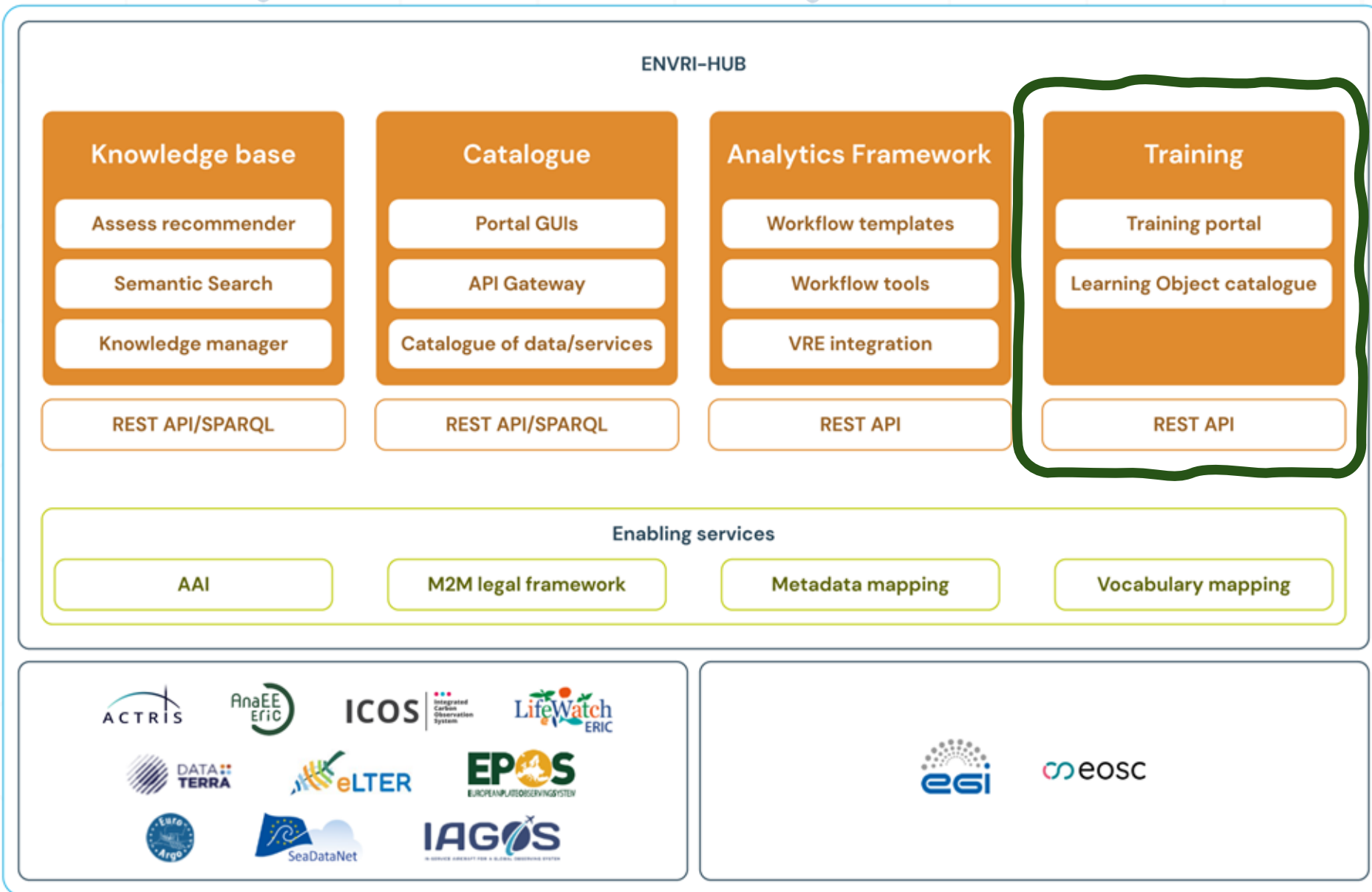
Start date
24-11-2024

Ui language
English

Metadata identifier
[identifier](#)

RDF metadata for machines
[ttl_rdfxml_icos_id](#)

Architecture of ENVRI-HUB





Training

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

Keyword(s)

Example: Winter School

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 AAA) 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 the 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

FAIRNESS

Navigation

Home

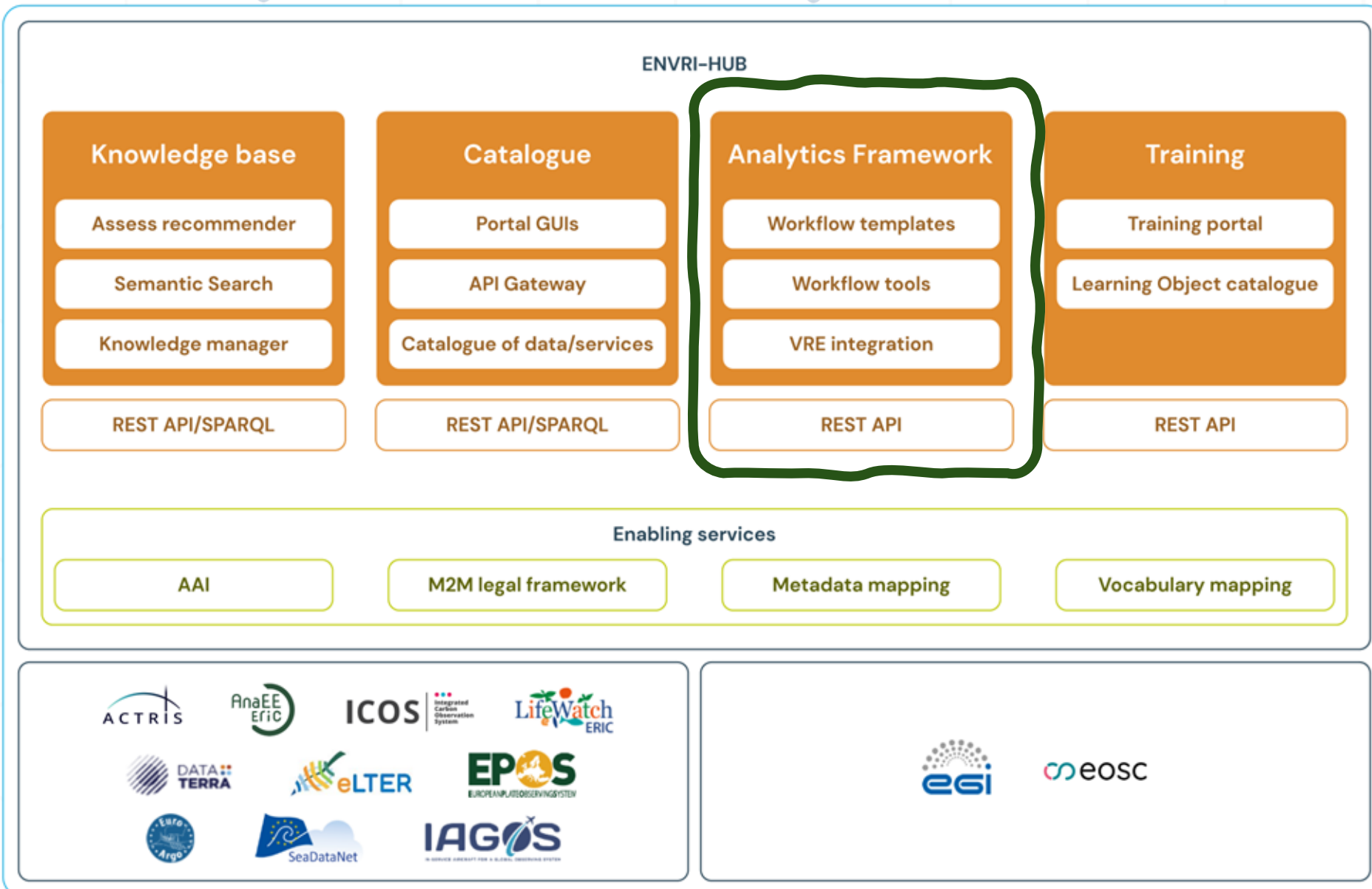
Courses

Calendar

July 2026

Mon	Tue	Wed	Thu	Fri	Sat	Sun
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Architecture of ENVRI-HUB



use your own VRE or check the test VRE

Programmatic access to the ENVRI-Hub services



```

[14]: 1 #!pip install matplotlib cartopy numpy pandas

Proof of concept notebook of notebooks
This notebook shows the PoC python library (ehnp) in action.

[5]: 1 import ecv_data_access.functions as functions
    2 import matplotlib.pyplot as plt
    3 import cartopy.crs as ccrs
    4 import cartopy.feature as cfeature
    5 import numpy as np
    6 import pandas as pd

[6]: 1 ## Argo & SDN
    2 #EXV017 Sea-surface temperature (SDN / Euro-Argo) -->
    3 #EXV018 Subsurface temperature (SDN / Euro-Argo) -->
    4 #EXV019 Sea Surface Salinity (SDN / Euro-Argo) -->
    5 #EXV020 Subsurface Salinity (SDN / Euro-Argo) -->
    6 #EXV028 Oxygen (SDN / Euro-Argo) -->
    7 #EXV029 Nutrients (SDN / Euro-Argo) -->
    8 #EXV033 Ocean color (SDN / Euro-Argo) -->
    9
    10 ## ACTRIS & SDN
    11 #EXV011 Cloud properties (ACTRIS / SDN) ?
    12 #EXV016 Aerosol properties (ACTRIS / SDN) -->
    13
    14 ## ICOS & SDN
    15 #EXV013 Carbon dioxide, methane and other greenhouse gases (ICOS / SDN) -->
    16
    17 ## EPOS & SDN
    18 #EXV023 Sea Level (SDN / EPOS) -
    19
    20 ## Individual RIs
    21 #EXV014 Ozone ?
    22 #EXV015 Precursors (supporting the aerosol and ozone ECVs) (IAGOS) -->
    23 #EXV022 Subsurface Currents (Euro-Argo) -
    24 #EXV030 Ocean Inorganic Carbon (SDN) -
    25 #EXV039 Soil moisture (ICOS) -

[7]: 1 exv = "EXV015"
    2 region=(10, 20, 45, 65)
    3 time=("2020-01-01", "2020-01-10")
    4 samplingheight=(0, 100)

[8]: 1 data = functions.get_data(
    2     exv_variable=exv,
    3     region=region,
    4     time=time,
    5     samplingheight=samplingheight
    6 )

[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/

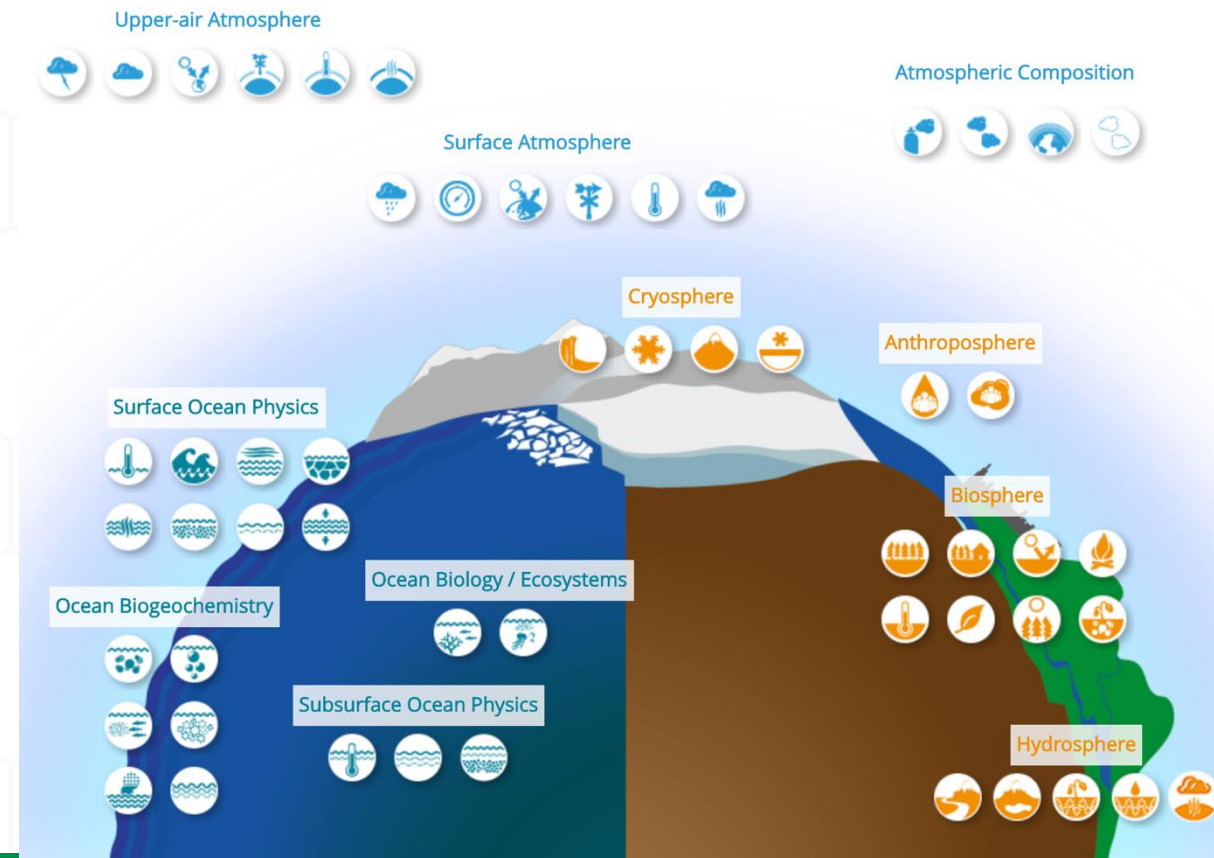
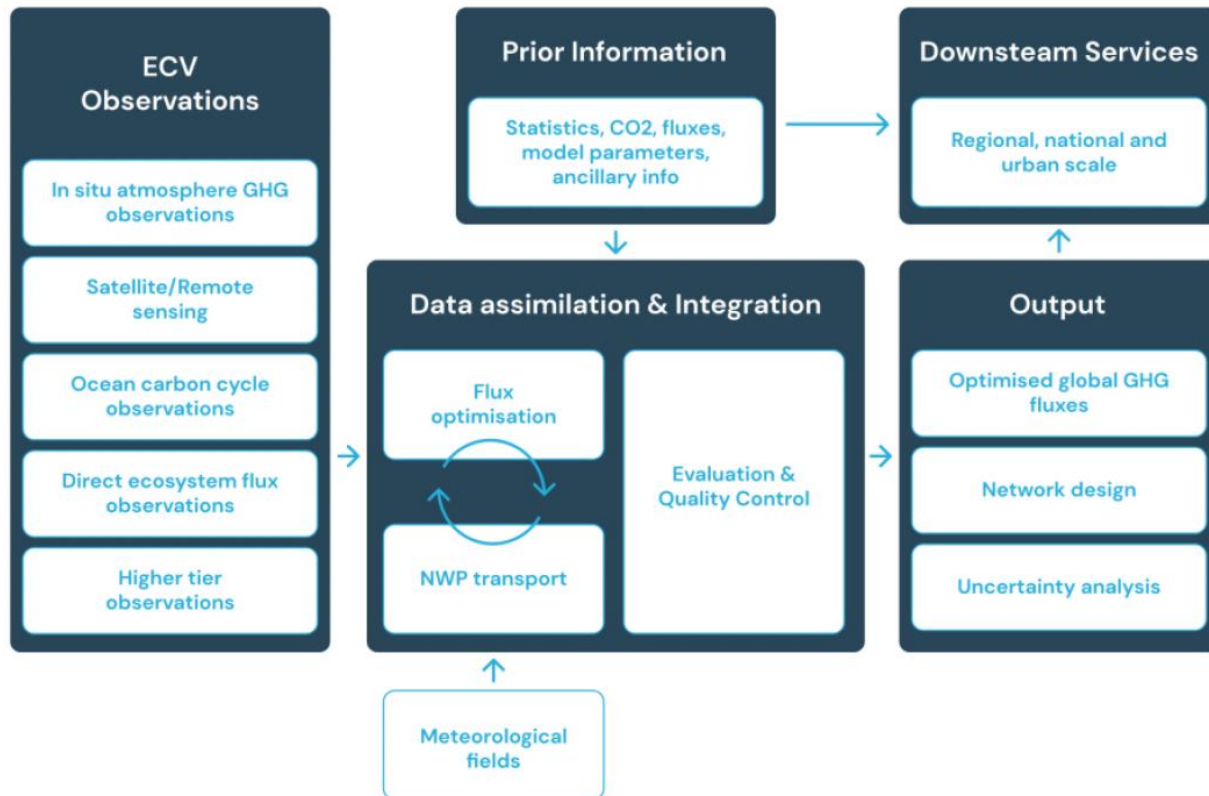
```



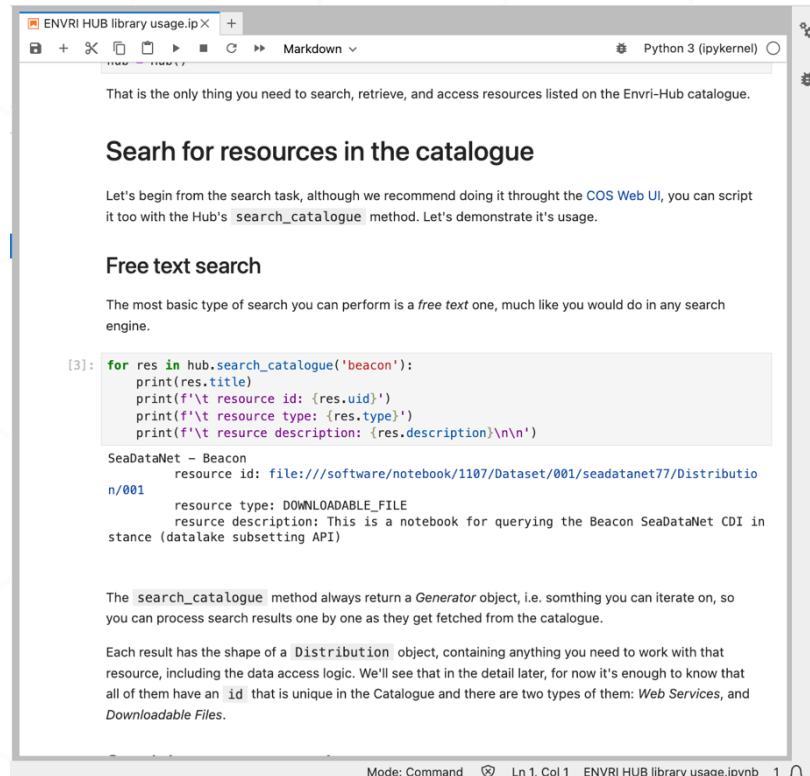
2. Essential Climate Variables (ECV)

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.



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



That is the only thing you need to search, retrieve, and access resources listed on the Envri-Hub catalogue.

Search for resources in the catalogue

Let's begin from the search task, although we recommend doing it through the [COS Web UI](#), you can script it too with the Hub's `search_catalogue` method. Let's demonstrate it's usage.

Free text search

The most basic type of search you can perform is a *free text* one, much like you would do in any search engine.

```
[3]: for res in hub.search_catalogue('beacon'):
    print(res.title)
    print(f'\t resource id: {res.uid}')
    print(f'\t resource type: {res.type}')
    print(f'\t resource description: {res.description}\n\n')
```

SeaDataNet - Beacon
 resource id: file:///software/notebook/1107/Dataset/001/seadatanet77/Distribution/001
 resource type: DOWNLOADABLE_FILE
 resource description: This is a notebook for querying the Beacon SeaDataNet CDI in stance (datalake subsetting API)

The `search_catalogue` method always return a *Generator* object, i.e. something you can iterate on, so you can process search results one by one as they get fetched from the catalogue.

Each result has the shape of a `Distribution` object, containing anything you need to work with that resource, including the data access logic. We'll see that in the detail later, for now it's enough to know that all of them have an `id` that is unique in the Catalogue and there are two types of them: *Web Services*, and *Downloadable Files*.



Sou 1



Sou 2



Sou 3





EuroArgo

May 2021

European contribution to the Argo program via EuroArgo Research Infrastructure
 (last locations of operational profiling floats (data distributed within the last 30 days))

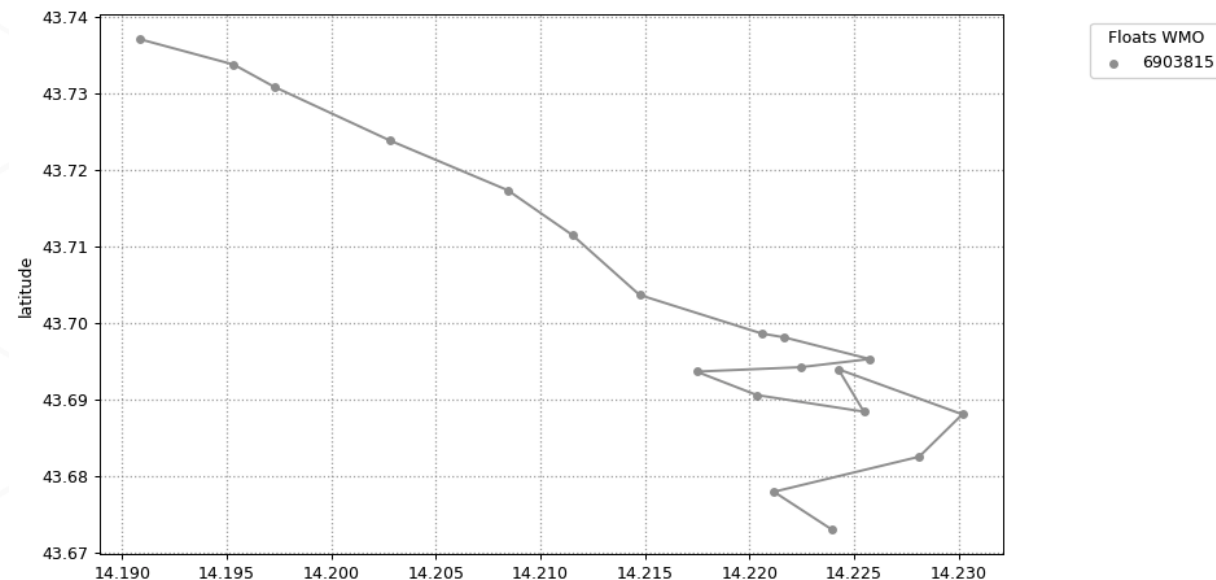
• Argo EU (913) • Argo non EU (2956)

European floats representing 23% of the global network

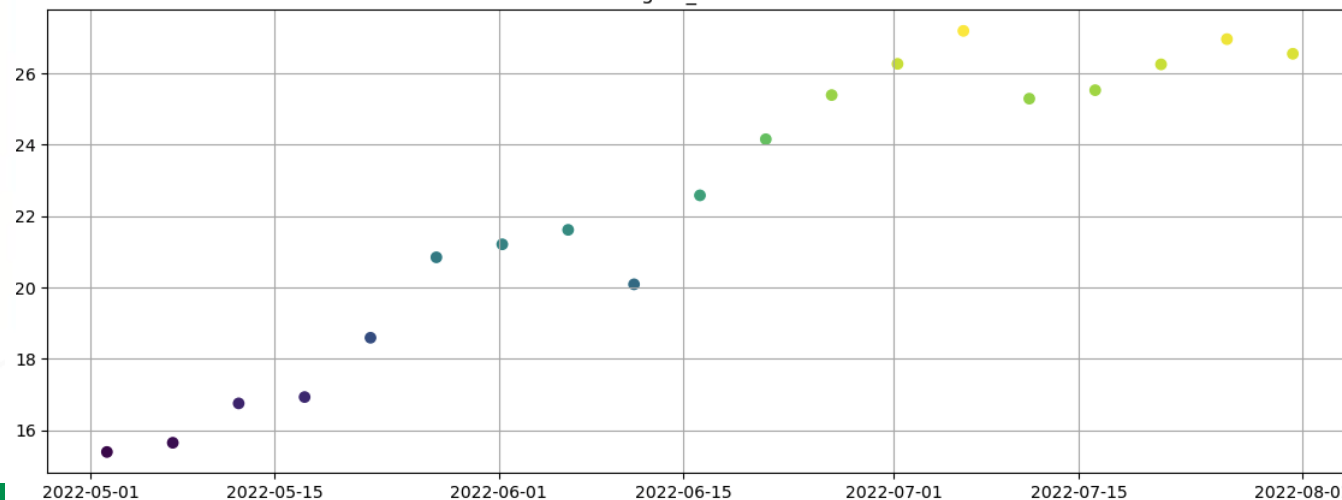
Generated by ocean-ops.org, 2021-06-10
 Projection: Plate Carree



© Lauren O'Deill/A



SEA TEMPERATURE IN SITU ITS-90 SCALE and in degree_Celsius at the surface betw. 2022-05-01 and 2022-08-01





ENVRI-HUB

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

The screenshot shows the PyPI page for envrihub 0.1.4. It includes the project description: "ENVRI Hub's VRE Library. This is the official ENVRI-Hub Python library, its purpose is to streamline interaction with the ENVRI-Hub APIs, providing a pythonic facade to data and service access." It also features a quickstart section with installation instructions: "pip install envrihub" and "After installing the package with a quick: pip install envrihub".

The screenshot shows a Jupyter notebook titled "ECV-data-access_usage_example_for_ocean_temperature.ipynb". It contains code for installing the envrihub library and using it to access ocean temperature data. The code includes comments in Chinese explaining the steps: "First install the latest version of the envrihub library and use its outputs to plot ocean temperature from two sources of data." and "Now import the libraries".

The screenshot shows an ECV workflow diagram. It is a visual representation of a data processing pipeline. The workflow starts with "envrihub-search-catalogue" and "envrihub-fetch-from-catalogue", which lead to "load-remote-sensor-zhimo". This is followed by "load-weather-data-zhimo", "weather-model-zhimo", and "inference-zhimo-zhao-f". The final output is "envrihub-plot-quantum-flow". The diagram uses colored circles to represent different data types or stages.

The screenshot shows a search interface for datasets. It includes a search bar and a list of authoritative sources where you can find and download surface ocean temperature datasets relevant to the Netherlands for the year 2023. The sources listed are: 1. SeaDataNet (Aggregated Datasets & Climatologies), 2. ARGO Ocean Temperature Data (Surface/Subsurface, Europe), 3. Sea Surface Temperature (SST) Analysis Datasets, and 4. ODATIS Data Portal. Each source is accompanied by a brief description and a link to the dataset.

Environmental Expert: enhance other search systems

Environmental Expert...

Ask any question about the Environment and Earth Science

How do I collect the Surface temperature

What questions do you have about Environment?



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 regional climatologies.
- Access datasets:
<https://www.seadatanet.org/About-us/News/New-release-of-OCTOPUS-1.11.0>

2. ARGO Ocean Temperature Data (Surface/Subsurface, Europe)

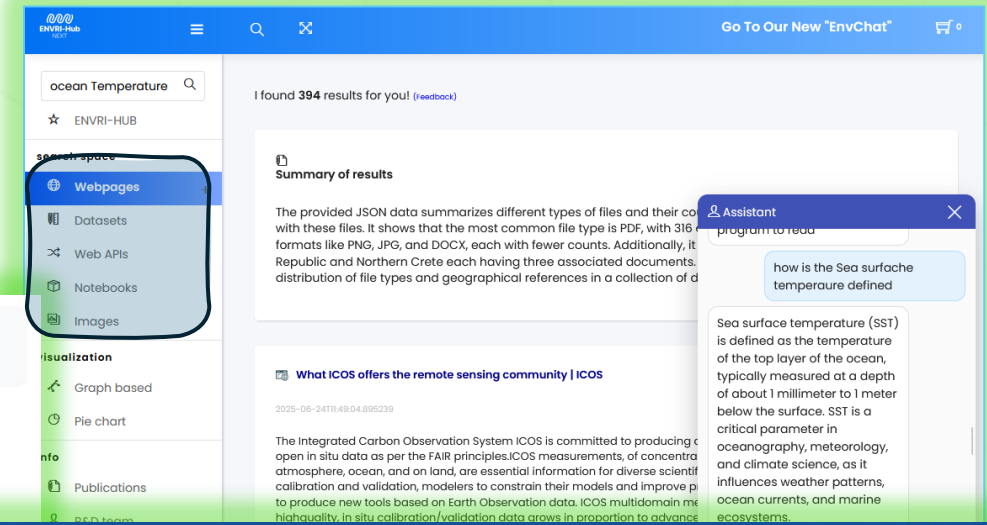
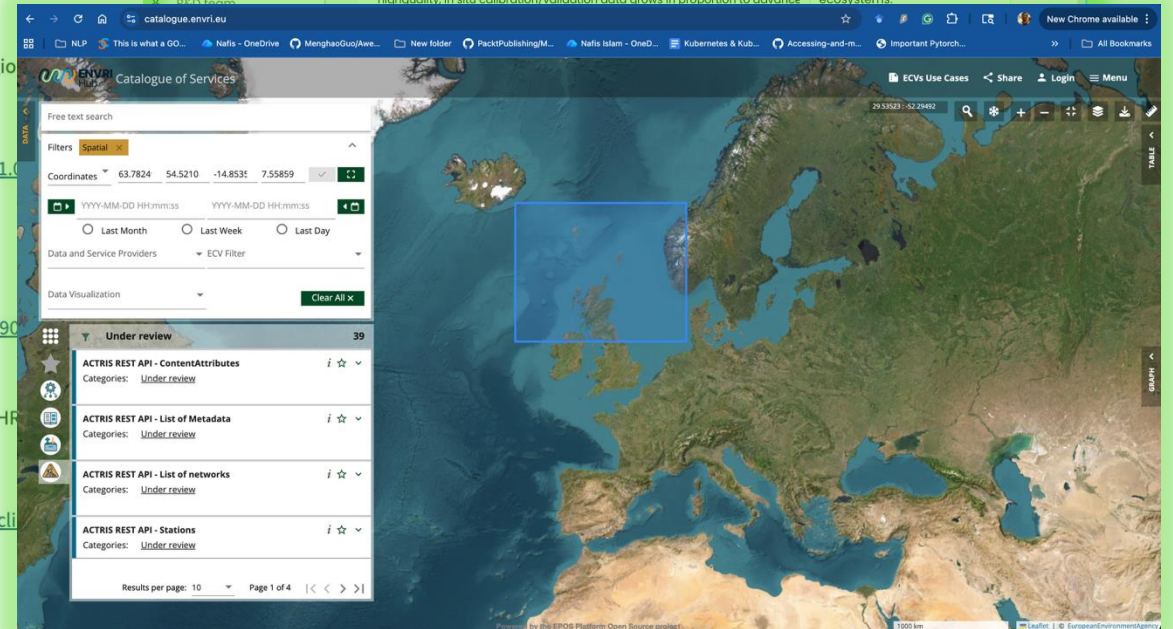
- Latest ARGO float data for European seas including the North Sea.
- Catalogue and related services:
<https://catalogue.staging.envri.eu/?share=94898cf2-a4cc-43a6-befa-7c150a90>

3. Sea Surface Temperature (SST) Analysis Datasets

- Overview page with links to various SST analysis datasets, such as NOAA AVHRR, ODYSSEA SST, and others.
- Dataset list and access:
<https://gcos.wmo.int/site/global-climate-observing-system-gcos/essential-climate-variables/sea-surface-temperature>

4. ODATIS Data Portal

What questions do you have about Environment?

Environmental Expert: for problem solving

Environmental Expert

Ask any question about the Environment and Earth Science

How do I collect the Surface temperature

Find me the methods to calculate

Here are methods and specifications for Ocean Temperature:

1. GCOS Measurement Specifications

- Horizontal Resolution: 100 km.
- Temporal Resolution: 1 day
- Timeliness: Data should be available within 1 month
- Required Measurements: Sea Surface Temperature (SST)
- These specifications are for variability and change detection

More details:

<https://gcos.wmo.int/site/variables/sea-surface-temperature>

2. EOVS (Essential Ocean Variables)

- Provides standardized measurements
- Measurements derived from buoys, and ships.
- Describes data processing

What questions do you have about

How do I use the envrihub

You can use the envrihub to stream data and serve

1. Install the library:

```
pip install envrihub
```

2. Example usage (fetching data)

```
from envrihub import EnvriHub
res = hub.fetch_data('sea_surface_temperature',
# Access as a byte stream
byte_stream = res.get_byte_stream()
# Or download the data
res.dao.download('sea_surface_temperature')
```

3. For interacting with the data

```
from envrihub.data import DataFetcher
# Build a client for the data
```

What questions do you have about

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

jupyter Powerline extraction using PointCNN_raw Last Checkpoint: 04/12/2021 Autosave Failed!

File Edit View Insert Cell Kernel Widgets Help

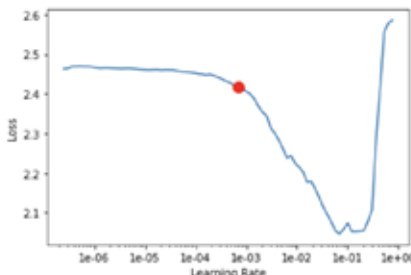
Not Trusted Python 3

```
In [7]: pc = PointCNN(data)
```

Finding optimal starting learning rate

Next, `lr_find()` function is used to find the optimal learning rate. It controls the rate at which existing information will be overwritten by newly acquired information throughout the training process. If no value is specified, the optimal learning rate will be extracted from the learning curve during the training process.

```
In [9]: pc.lr_find()
```



Out[9]: 0.0006918309709189362

RStudio

flights-example.R

```
1 library(nycflights13) ## package containing flights dataset
2 library(lubridate)
3 library(dplyr)
4 library(ggplot2)
5
6 head(flights, n = 3)
7 daily <- flights %>%
8   mutate(date = make_date(year, month, day)) %>%
9   count(date) %>%
10  mutate(wday = wday(date, label = TRUE))
11 head(daily, n = 3)
12 ggplot(daily, aes(wday, n)) +
13   geom_boxplot(outlier.colour = "hotpink") +
14   labs(x = "Weekday", y = "Flights",
15        subtitle = "Number of 2013 New York Flights Each Weekday")
16
```

Environment History Connections Tutorial

R Global Environment

Data

daily 365 obs. of 3 variables

\$ date: Date[1:365], format: "2013-01-01" "2013-01-02" ...

\$ n : int [1:365] 842 943 914 915 720 832 933 899 902...

\$ wday: Ord.factor w/ 7 levels "Sun"<"Mon"<"Tue"<... 3 ...

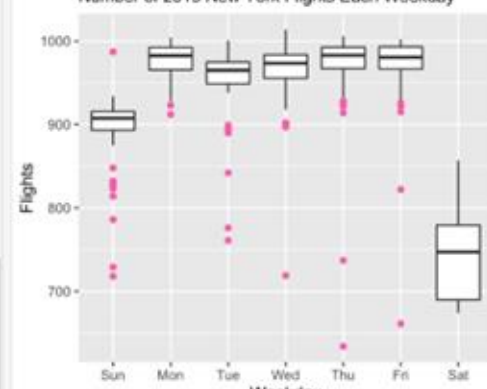
Console Terminal Jobs

```
~/Documents/Flights/ >
# A tibble: 3 x 10
  year month day dep_time sched_dep_time dep_delay arr_time sched_arr_time arr_delay carrier
<int> <int> <int> <chr> <chr> <dbl> <chr> <chr> <dbl> <chr>
1 2013 1 1 1 517 515 2 830 819 11 UA
2 2013 1 1 533 529 4 850 830 20 UA
3 2013 1 1 542 540 2 923 850 33 AA
# ... with 9 more variables: flight <int>, tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>,
# distance <dbl>, hour <dbl>, minute <dbl>, time_hour <dtm>
> daily <- flights %>%
+   mutate(date = make_date(year, month, day)) %>%
+   count(date) %>%
+   mutate(wday = wday(date, label = TRUE))
> head(daily, n = 3)
# A tibble: 3 x 3
  date n wday
<date> <int> <ord>
1 2013-01-01 842 Tue
2 2013-01-02 943 Wed
3 2013-01-03 914 Thu
> ggplot(daily, aes(wday, n)) +
+   geom_boxplot(outlier.colour = "hotpink") +
+   labs(x = "Weekday", y = "Flights",
+        subtitle = "Number of 2013 New York Flights Each Weekday")
```

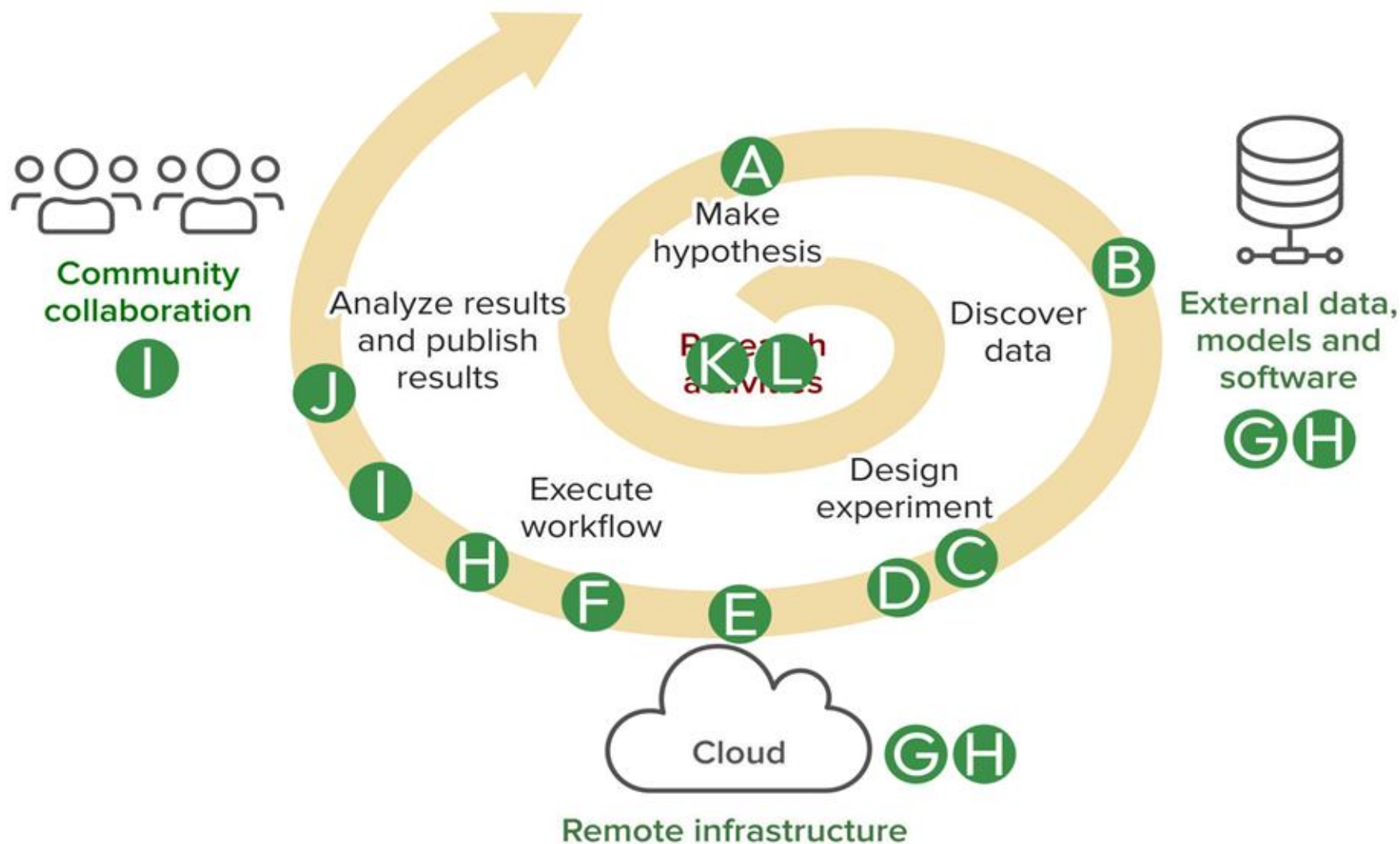
Files Plots Packages Help Viewer

Zoom Export

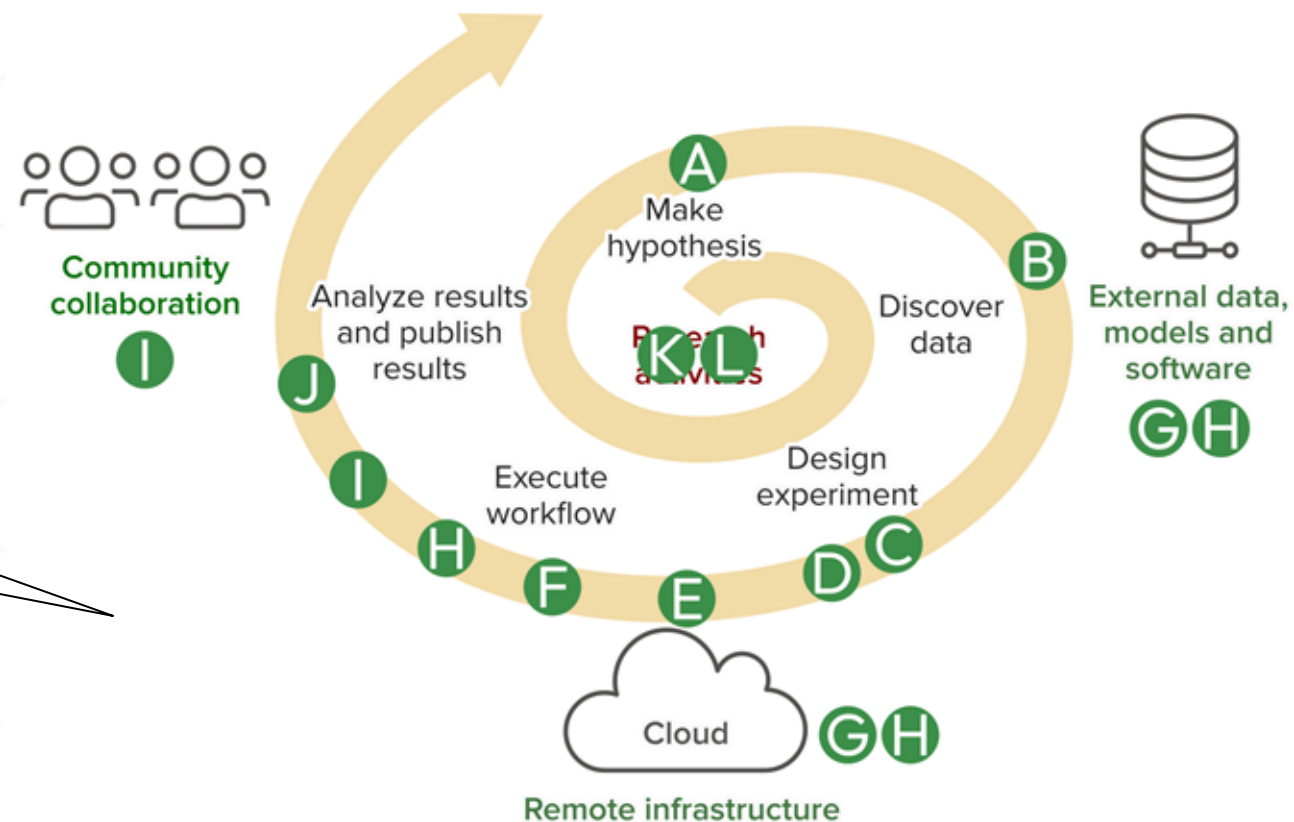
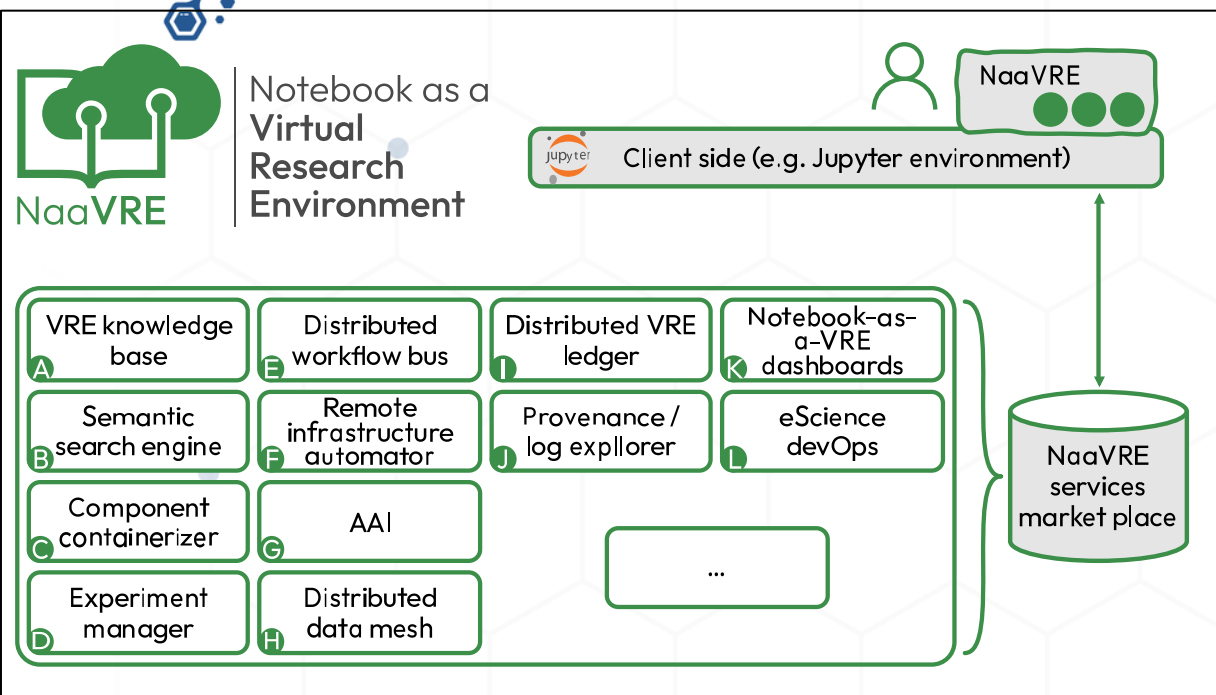
Number of 2013 New York Flights Each Weekday



Challenges



Research activities and Jupyter extensions

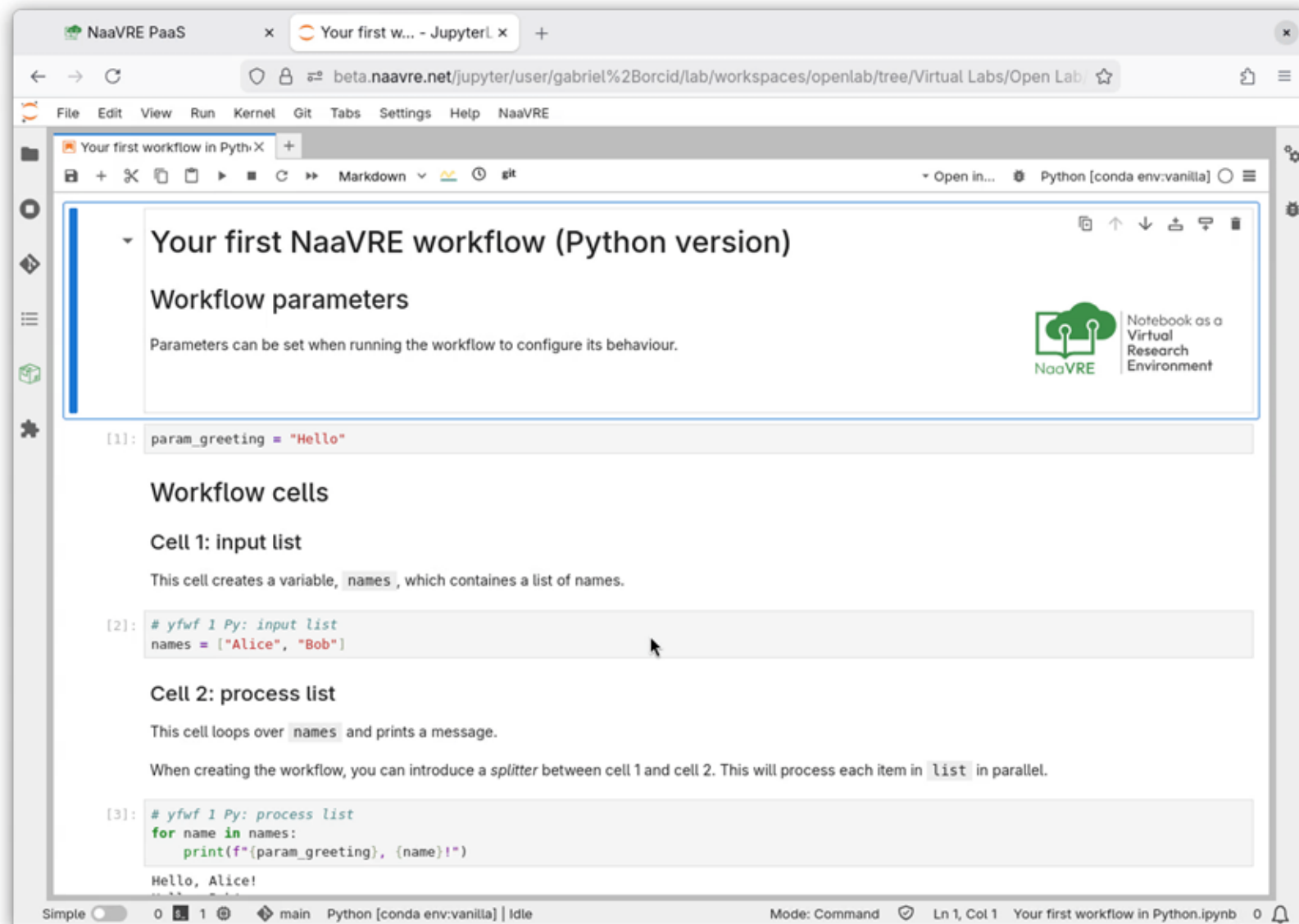
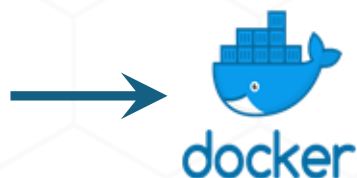


From notebooks to cloud workflows

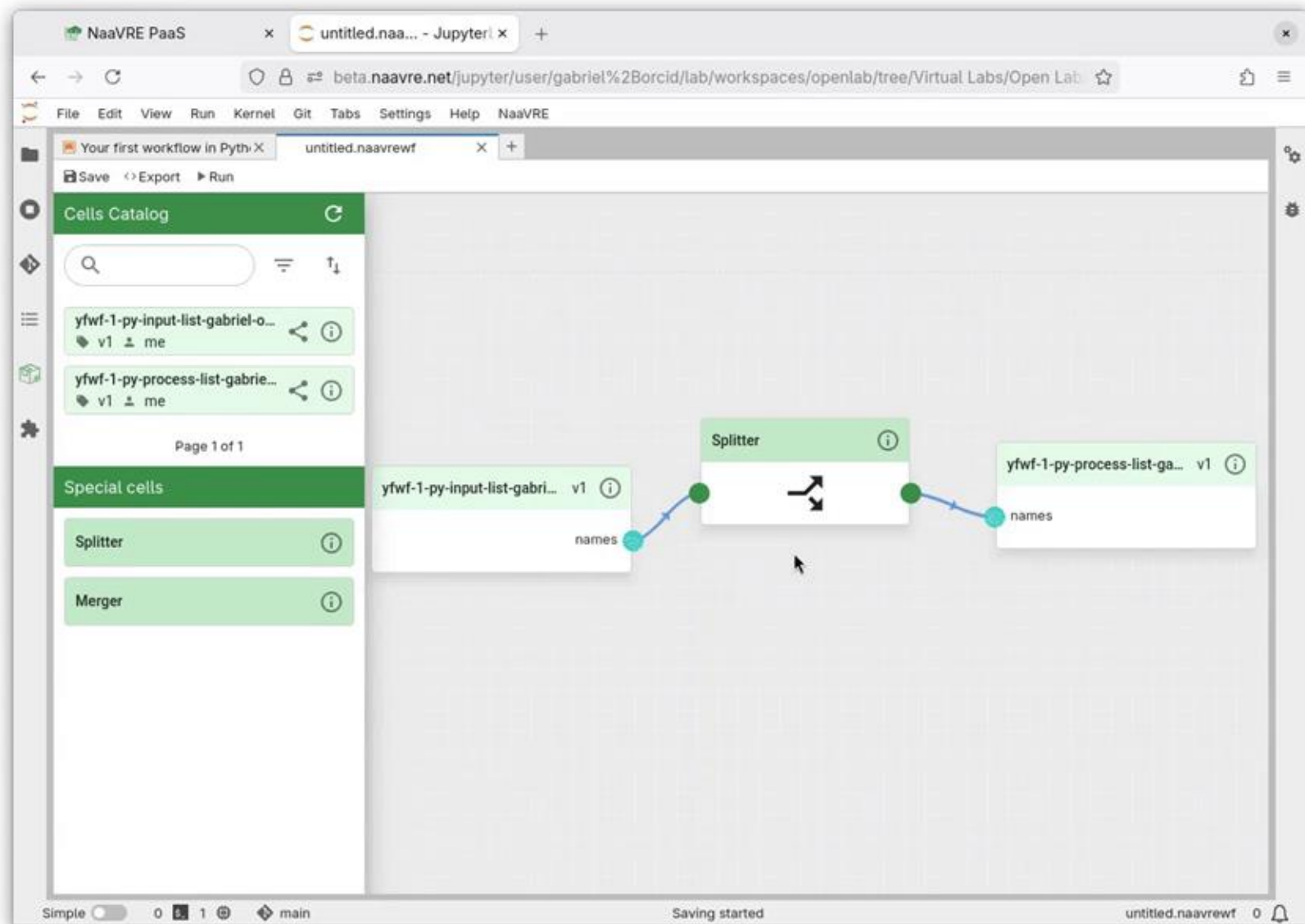
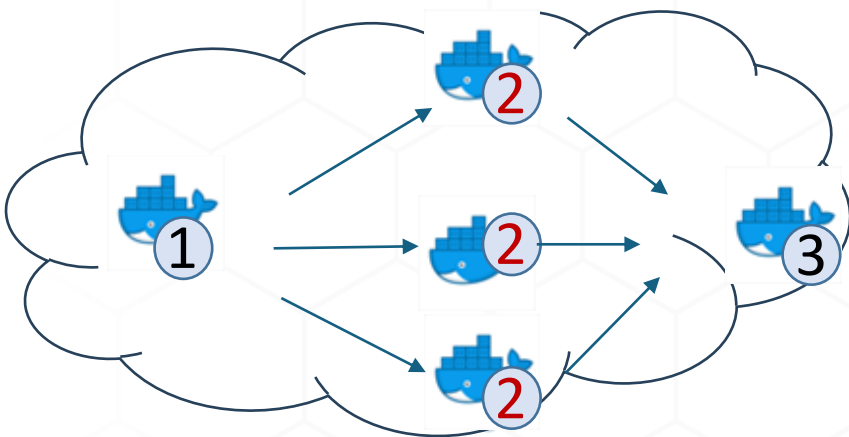
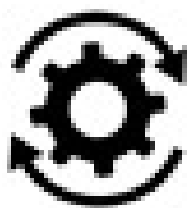
Containerize notebook cell

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

Code cell



From notebooks to cloud workflows



From notebooks to cloud workflows

Workflow run

Notebook cell

Workflow component

Workflow template



```

# Fetching Laz Files from remote location 1
from minio import Minio
import boto3

def fetch_laz_files(remote_location):
    minio_client = Minio(remote_location, access_key='minio', secret_key='minio123', secure=True)
    objects = minio_client.list_objects(remote_location, recursive=True)
    for obj in objects:
        print(obj)
        minio_client.fget(obj, local_file_path=obj.name)

fetch_laz_files(
    ["s3://BUOY-LAZ", "s3://BUOY-LAZ", "s3://BUOY-LAZ"])

# Splitting big files into smaller files before retiling
This step can be added if the original files are too large for normal VRE to process

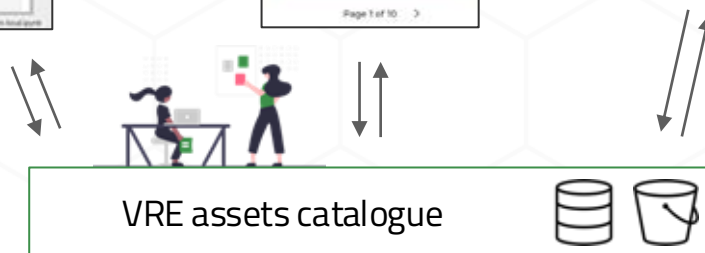
if __name__ == '__main__':
    import sys
    import os
    import shutil

    def main():
        # Read points from a LAZ/LAZ file and write them to a new file.
        points = read_points(sys.argv[1])
        with open(points, 'w') as f:
            f.write(points)

    main()
    
```



Cells Catalog	
s3-in-argo-2-read-gabriel-pel...	draft v2 & me
s3-in-argo-1-write-gabriel-pe...	draft v2 & me
yfml-1-py-process-list-gabrie...	v5 & me
yfml-1-py-input-list-gabrie...	v15 & me
minio-data-retriever-gabriel...	v1 & me
set-a-gabriel-pelouze-lifewat...	v3 & me
print-a-gabriel-pelouze-lifew...	v1 & me
print-a-gabriel-pelouze-lifew...	v1 & me
set-a-gabriel-pelouze-lifewat...	v1 & me
minio-pjjetty-e-4-gabriel-pe...	v1 & me



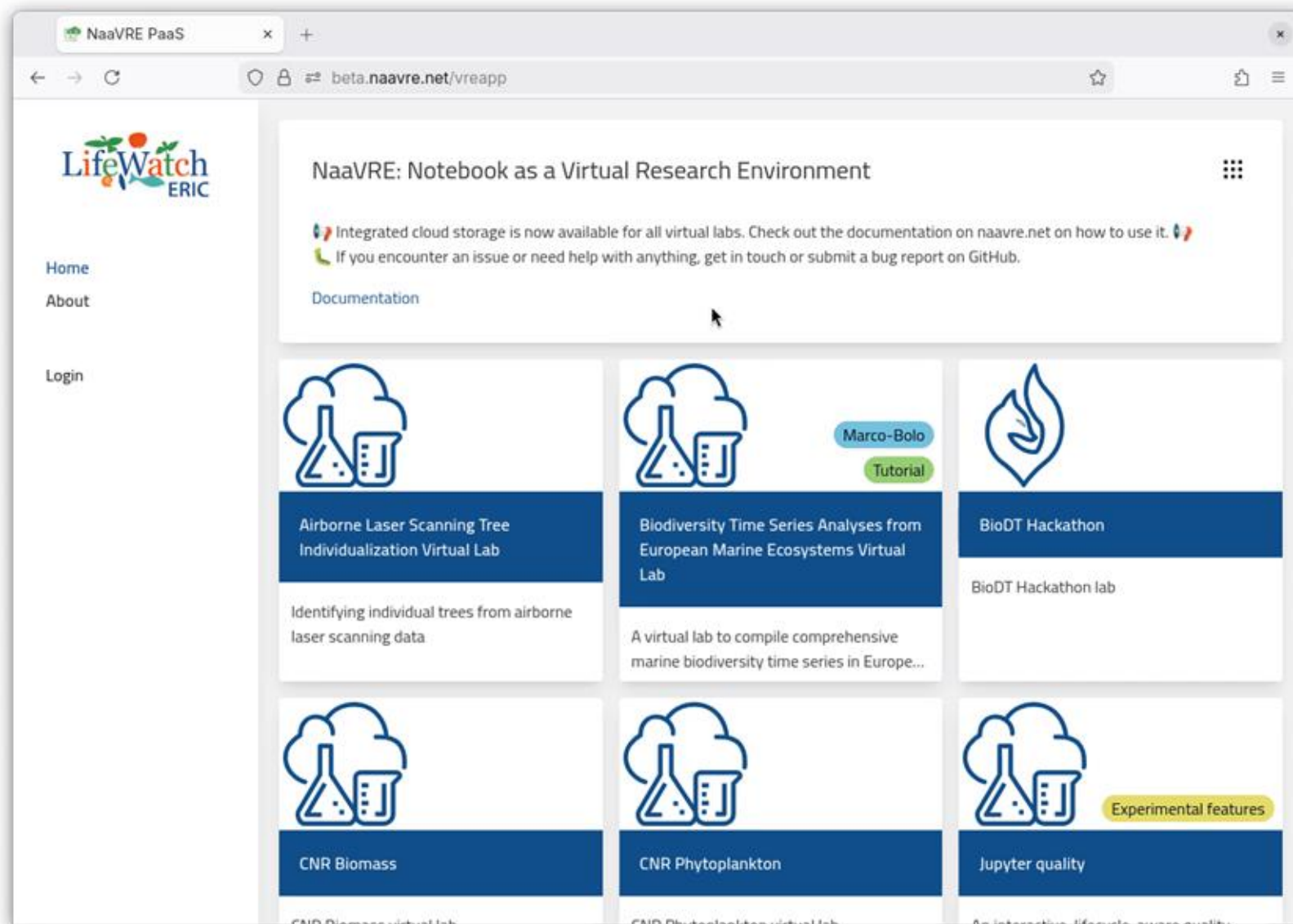
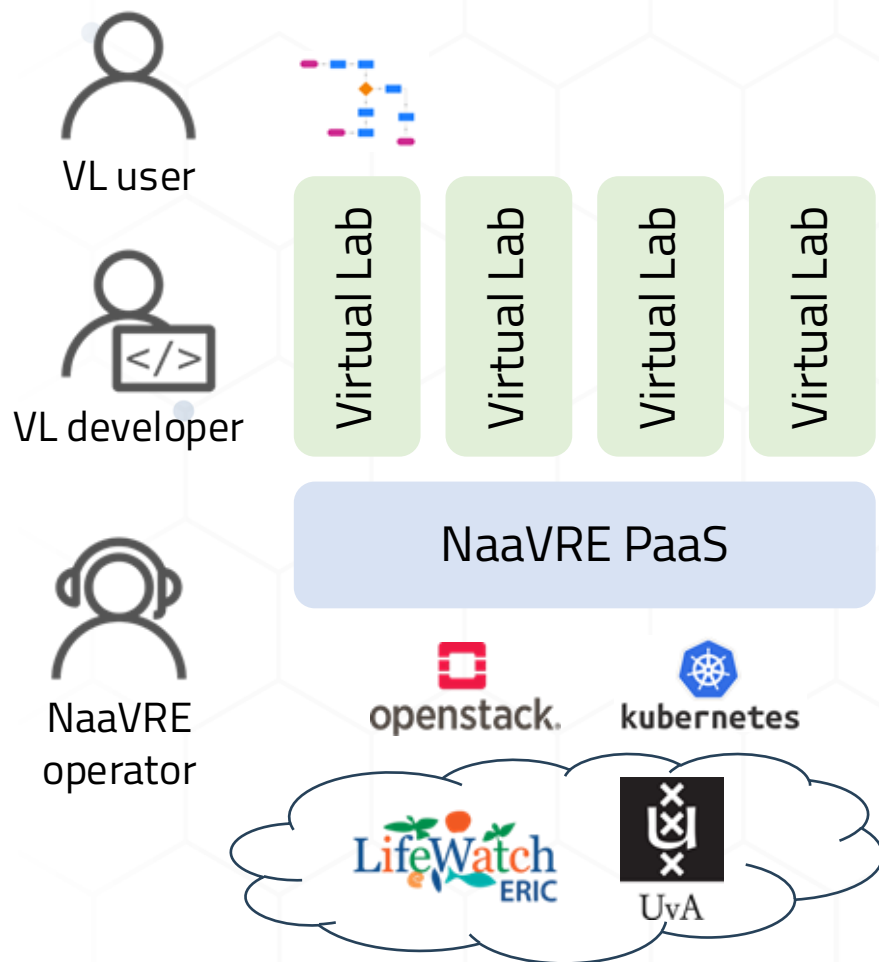
Workflow Results

Data storage





Notebook-as-a-VRE and Virtual Labs





Steps

www.naavre.net

NaaVRE Documentation

 Notebook as a Virtual Research Environment

Follow the tutorial Open NaaVRE **Open ECVs Virtual Lab**



beta.naavre.net/vreapp/vl/ecvs

LifeWatch ERIC

Essential Climate Variables Virtual Lab

A virtual lab to access ECVs. The workflows in the VLab were developed by ENVRI-Hub-NEXT project.

Home
About
Login

Login to see details

beta.naavre.net/vreapp/vl/ecvs

LifeWatch ERIC

Essential Climate Variables Virtual Lab

A virtual lab to access ECVs. The workflows in the VLab were developed by ENVRI-Hub-NEXT project.

Home
About

Logged in as Zhiming Zhao
[Logout]

Instances

10 instances

Pelouze Greuell Greuell Zhao Pan Greuell Guerrero Greuell Turco parisi

☐ Hide my instance from this list

Launch my instance

4. 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



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

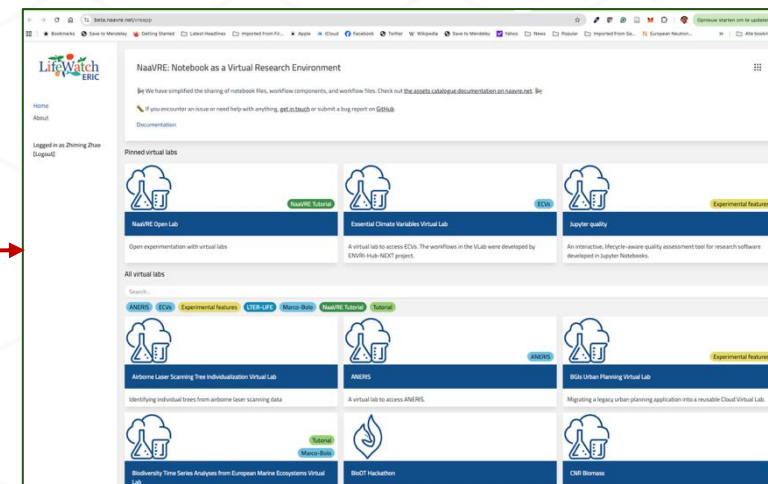
NaaVRE lets you create workflow components from Jupyter notebook cells and use these components to build workflows.



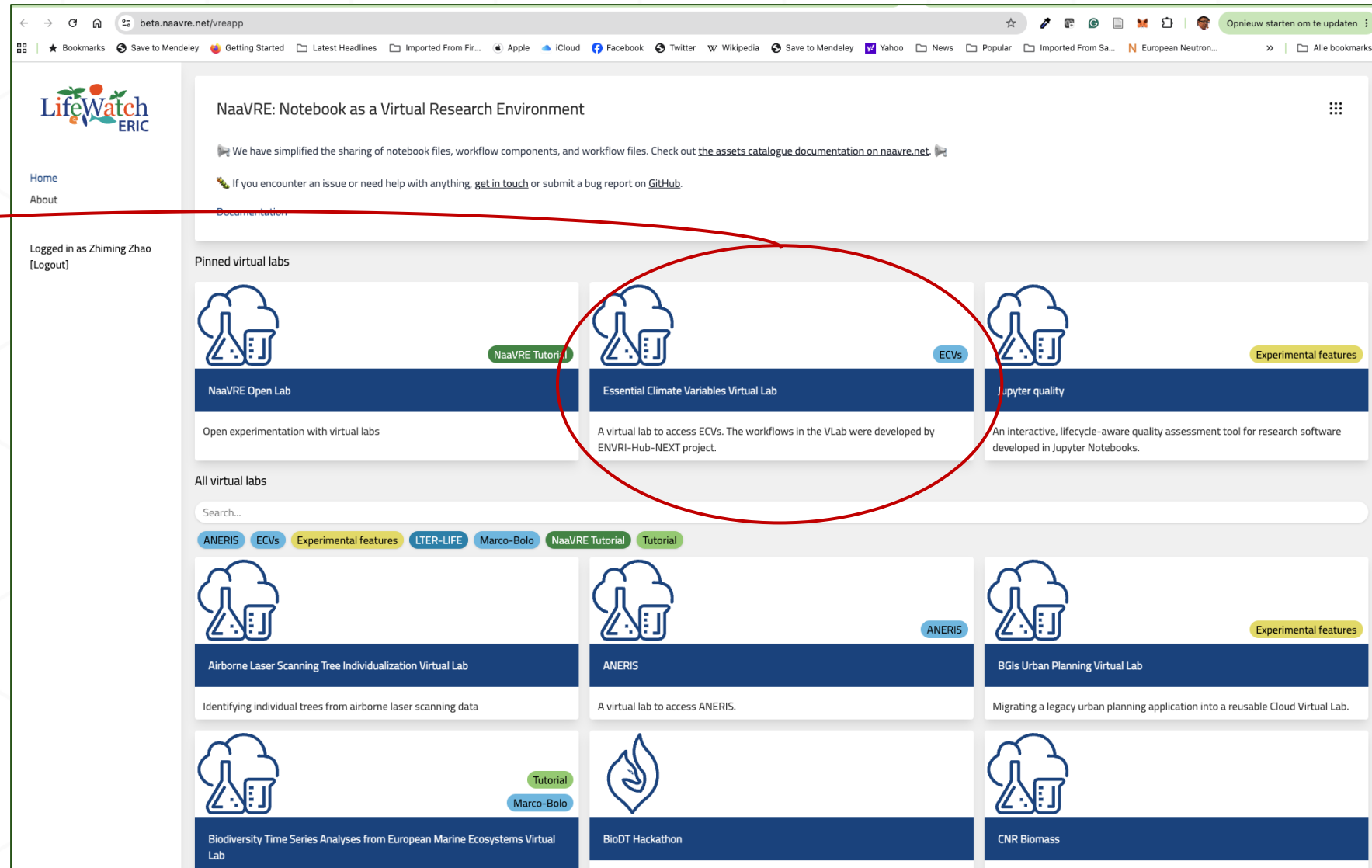
Run your workflows in the cloud

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

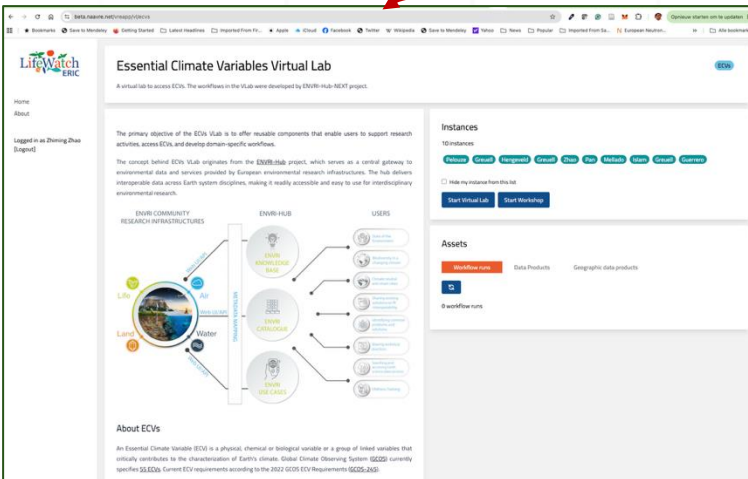
NaaVRE (Notebook as a Virtual Research Environment) is a user-centric platform that supports the full research lifecycle through customizable Virtual Labs. It streamlines collaboration by providing unified access to data, models, and software, while removing the complexity of creating and executing research workflows on the cloud¹².



How to access the Virtual Lab



The screenshot shows the NaaVRE web application interface. The browser address bar displays `beta.naavre.net/vreapp`. The page header includes the LifeWatch ERIC logo and navigation links for Home and About. A user is logged in as Zhiming Zhao, with a Logout link. The main content area is titled "NaaVRE: Notebook as a Virtual Research Environment" and contains a welcome message and links to documentation and GitHub. Below this, there are sections for "Pinned virtual labs" and "All virtual labs". The "Pinned virtual labs" section features three cards: "NaaVRE Open Lab", "Essential Climate Variables Virtual Lab" (highlighted with a red circle), and "Jupyter quality". The "All virtual labs" section includes a search bar and a grid of lab cards, such as "Airborne Laser Scanning Tree Individualization Virtual Lab", "ANERIS", "BGIs Urban Planning Virtual Lab", "Biodiversity Time Series Analyses from European Marine Ecosystems Virtual Lab", "BioDT Hackathon", and "CNR Biomass".



The screenshot shows the "Essential Climate Variables Virtual Lab" interface. The page header includes the LifeWatch ERIC logo and navigation links for Home and About. A user is logged in as Zhiming Zhao, with a Logout link. The main content area is titled "Essential Climate Variables Virtual Lab" and contains a description of the lab's purpose and a diagram illustrating the workflow. The diagram shows a central "ENVRI-HUB" connected to various "ENVRI-HUB NEXT" components, including "Data Products", "Geographic data products", and "Workflow components".



How to access the Virtual Lab

beta.naavre.net/vreapp/vj/ecvs

Opnieuw starten om te updaten

LifeWatch ERIC

Home
About

Logged in as Zhiming Zhao
[Logout]

Essential Climate Variables Virtual Lab

A virtual lab to access ECVs. The workflows in the VLab were developed by ENVRI-Hub-NEXT project.

The primary objective of the ECVs VLab is to offer reusable components that enable users to support research activities, access ECVs, and develop domain-specific workflows.

The concept behind ECVs VLab originates from the [ENVRI-Hub](#) project, which serves as a central gateway to environmental data and services provided by European environmental research infrastructures. The hub delivers interoperable data across Earth system disciplines, making it readily accessible and easy to use for interdisciplinary environmental research.

About ECVs

An Essential Climate Variable (ECV) is a physical, chemical or biological variable or a group of linked variables that critically contributes to the characterization of Earth's climate. Global Climate Observing System (GCOS) currently specifies 55 ECVs. Current ECV requirements according to the 2022 GCOS ECV Requirements (GCOS-245).

Instances

10 instances

Pelouze Greuell Hengeveld Greuell Zhao Pan Meliado Islam Greuell Guerrero

☐ Hide my instance from this list

Start Virtual Lab Start Workshop

Assets

Workflow runs Data Products Geographic data products

0 workflow runs

beta.naavre.net/vreapp/vj/ecvs

Opnieuw starten om te updaten

Harnessing the ENVRI-Hub: data, tools, and services for interdisciplinary research

Part 1

Start the first part of the training session in [step1](#).

Once finished with [step1](#), continue the short course in [step2](#), [step3](#) and [step4](#) optional.

Part 2

The second part of the training session begins on pen and paper. Once a first draft exists on physical paper, it will be ported to [NaavRE](#) using the instructions in [Co-design of a Virtual Lab](#).



How to access the Virtual Lab

beta.naavre.net/jupyter/user/zhiming.zhao@lifewatch.eu/lab/tree/Virtual%20Labs/ECVs/Git%20public/documentation/ENVRI-HUB_workshop/README.md

File Edit View Run Kernel Git Tabs Settings Help NaaVRE

/ ... / documentation / ENVRI-HUB_workshop /

Name	Modified
workflow	8 hours ago
Co-design of a Virtual Lab.ipynb	8 hours ago
README.md	8 hours ago
step1.ipynb	8 hours ago
step2.ipynb	8 hours ago
step3.ipynb	8 hours ago
step4-optional.ipynb	8 hours ago

A sample DT.ipynb | untitled1.naavre X | untitled.naavre X | ENVRI-Hub-Ab X | NERC-NVS_Ma X | ECV017.naavre X | README.md X | README.md X | ECVs-ARGO.oc X | log.md

file is read-only

Harnessing the ENVRI-Hub: data, tools, and services for interdisciplinary research

Part 1

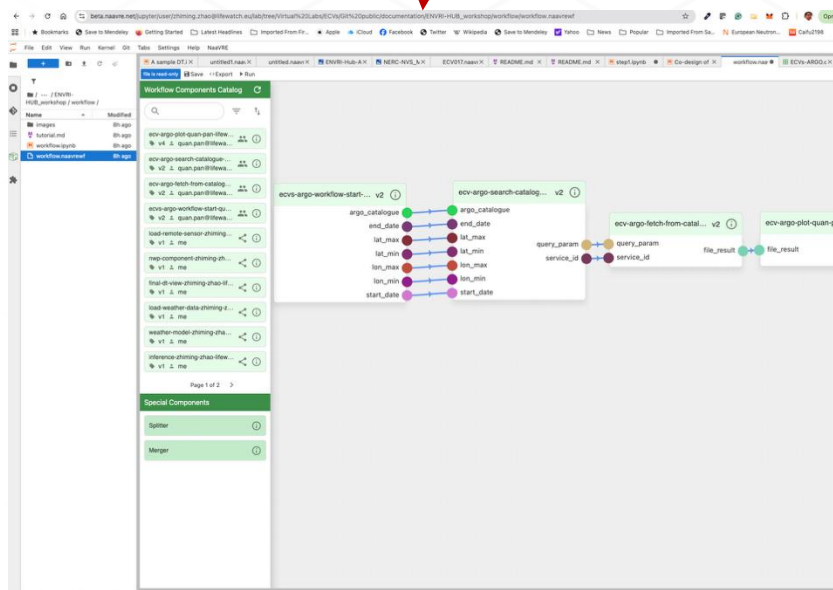
Start the first part of the training session in [step1.ipynb](#).

Once finished with step1, continue the short course in [step2](#), [step3](#) and [step4-optional](#).

Part 2

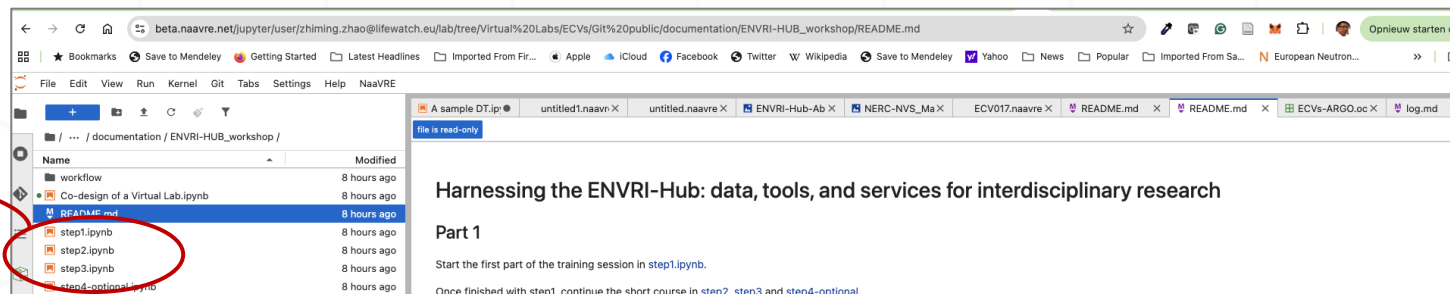
The second part of the training session begins on pen and paper. Once a first draft exists on physical paper, it will be ported to NaaVRE using the instructions in [Co-design of a Virtual Lab.ipynb](#).







How to access the Virtual Lab



Harnessing the ENVRI-Hub: data, tools, and services for interdisciplinary research

Part 1

Start the first part of the training session in [step1.ipynb](#).

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ENVRI HUB library usage

In this notebook we'll showcase the intended usage of the *VRE-Lib* component developed by WP 13 and WP 14. The *VRE-Lib* is available as a *Python* package on the [public package index](#) on the *envrihub* name. This means it can be installed with:

```
[1]: ! pip install --upgrade envrihub
! pip install openapi-spec-validator
```

```
Requirement already satisfied: envrihub in /opt/conda/envs/ecvs/lib/python3.14/site-packages (0.1.4)
Requirement already satisfied: shapely in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from envrihub) (2.1.2)
Requirement already satisfied: retry in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from envrihub) (0.9.2)
Requirement already satisfied: prance in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from envrihub) (25.4.8.0)
Requirement already satisfied: pandas in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from envrihub) (3.0.2)
Requirement already satisfied: argopy in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from envrihub) (1.4.0)
Requirement already satisfied: SPARQLWrapper in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from envrihub) (2.0.0)
Requirement already satisfied: xarray<=2025.9.0, >=2025.7 in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from argopy->envrihub) (2025.9.0)
Requirement already satisfied: scipy>=1.5 in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from argopy->envrihub) (1.17.1)
Requirement already satisfied: numpy in /opt/conda/envs/ecvs/lib/python3.14/site-packages (from argopy->envrihub) (2.4.3)
```

The main element you have to import is the *Hub* object:

```
[2]: from envrihub import Hub
```



How to access the Virtual Lab

beta.naavre.net/jupyter/user/zhiming.zhao@lifefwatch.eu/lab/tree/Virtual%20Labs/ECVs/Git%20public/documentation/ENVRI-HUB_workshop/workflow/workflow.naavref

File Edit View Run Kernel Git Tabs Settings Help NaaVRE

Workflow Components Catalog

ecv-argo-plot-quan-pan-lifew... v4 8h ago
tutorial.md 8h ago
workflow.ipynb 8h ago
workflow.naavref 8h ago

ecv-argo-search-catalogue... v2 8h ago
ecv-argo-fetch-from-catalog... v2 8h ago
ecvs-argo-workflow-start-qu... v2 8h ago
load-remote-sensor-zhiming... v1 8h ago
nwp-component-zhiming-zh... v1 8h ago
final-dt-view-zhiming-zhao-lif... v1 8h ago
load-weather-data-zhiming-z... v1 8h ago
weather-model-zhiming-zha... v1 8h ago
inference-zhiming-zhao-lifew... v1 8h ago

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Special Components

Splitter
Merger

ecvs-argo-workflow-start... v2
argo_catalogue
end_date
lat_max
lat_min
lon_max
lon_min
start_date

ecv-argo-search-catalog... v2
query_param
service_id

ecv-argo-fetch-from-catal... v2
file_result

ecv-argo-plot-quan-p

beta.naavre.net/jupyter/user/zhiming.zhao@lifefwatch.eu/lab/tree/Virtual%20Labs/ECVs/Git%20public/documentation/ENVRI-HUB_workshop/README.md

File Edit View Run Kernel Git Tabs Settings Help NaaVRE

workflow
Co-design of a Virtual Lab.ipynb
README.md
step1.ipynb
step2.ipynb

Harnessing the ENVRI-Hub: data, tools, and services for interdisciplinary research

Part 1

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BEeS 2026 ENVRI-Hub NEXT



How to access the Virtual Lab

beta.naavre.net/jupyter/user/zhiming.zhao@lifewatch.eu/lab/tree/Virtual%20Labs/ECVs/Git%20public/documentation/ENVRI-HUB_workshop/workflow/workflow.naavrewf

File Edit View Run Kernel Git Tabs Settings Help NaaVRE

untitled1.naav... untitled.naav... ENVRI-Hub-A X NERC-NVS_N X ECV017.naav X README.md X README.md X step1.ipynb Co-design of X workflow.naav ECVs-ARGO.c X

file is read-only Save Export Run

Workflow Components Catalog

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Name Modified

images 8h ago

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workflow.ipynb 8h ago

workflow.naavrewf 8h ago

ecv-argo-plot-quan-pan-lifewa... v4 quan.pan@lifewa...

ecv-argo-search-catalogue... v2 quan.pan@lifewa...

ecv-argo-fetch-from-catalog... v2 quan.pan@lifewa...

ecvs-argo-workflow-start-qu... v2 quan.pan@lifewa...

load-remote-sensor-zhiming... v1 me

nwp-component-zhiming-zh... v1 me

final-dt-view-zhiming-zhao-lif... v1 me

load-weather-data-zhiming-z... v1 me

weather-model-zhiming-zha... v1 me

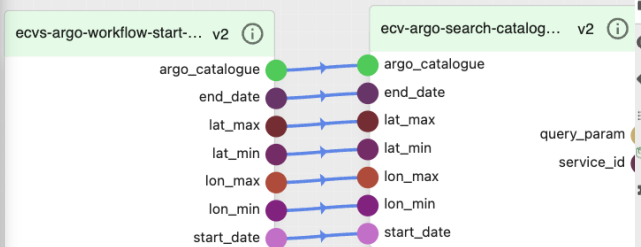
inference-zhiming-zhao-lifewa... v1 me

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Special Components

Splitter

Merger



beta.naavre.net/jupyter/user/zhiming.zhao@lifewatch.eu/lab/tree/Virtual%20Labs/ECVs/Git%20public/documentation/ENVRI-HUB_workshop/workflow/workflow.naavrewf

File Edit View Run Kernel Git Tabs Settings Help NaaVRE

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ecv-argo-fetch-from-catalog... v2 quan.pan@lifewa...

ecvs-argo-workflow-start-qu... v2 quan.pan@lifewa...

load-remote-sensor-zhiming... v1 me

nwp-component-zhiming-zh... v1 me

final-dt-view-zhiming-zhao-lif... v1 me

load-weather-data-zhiming-z... v1 me

weather-model-zhiming-zha... v1 me

inference-zhiming-zhao-lifewa... v1 me

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Special Components

Splitter

Merger

Run Workflow

Use default parameter values

param_argo_catalogue ocean temperature

param_end_date 2025-01-01

param_lat_max 48.34

param_lat_min 42.17

param_lon_max 18.98

param_lon_min 10.7

param_start_date 2024-01-01

param_workflow_name workflow name

Make recurring RUN

5. Feedback



Feedback

- <https://www.menti.com>
- Code: 7804 0981



menti.com
7804 0981



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THANK YOU!

Questions?

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