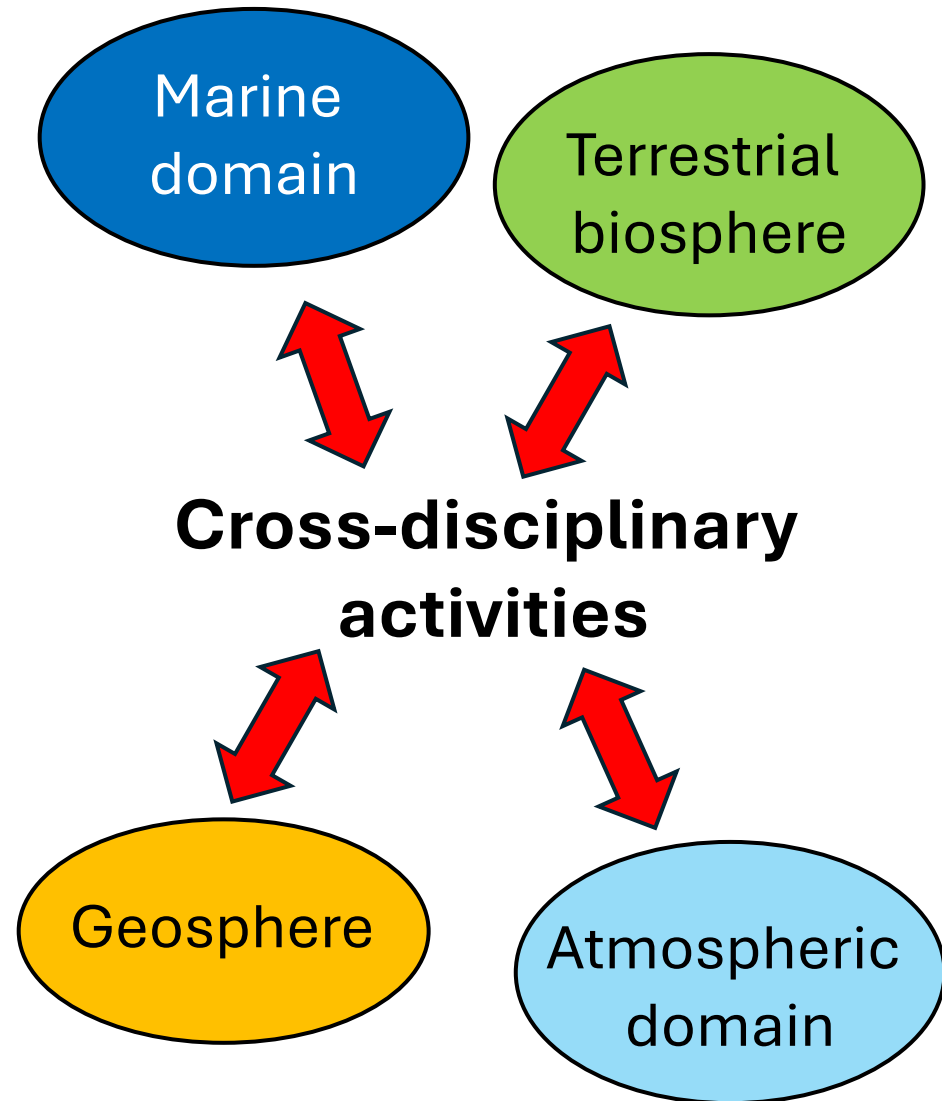


WP8. Virtual Research Environments and cross-disciplinary activities

- **Lead:** Antonello Provenzale, CNR-IGG
- **Co-lead:** Eugenio Trumpy, CNR-IGG
- **Support group:**
Gianpaolo Coro, CNR-ISTI;
Letizia Costanza, CNR-IGG;
Laura Criscuolo, CNR-IGG,
Alessandro Oggioni, CNR-IREA



von Humboldt and Bonpland,
Naturgemälde

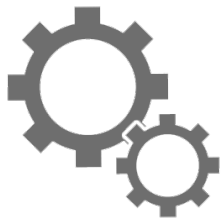


The activities of WP8 use data, information and knowledge generated by the individual RI to create a **system of Virtual Research Environments (VRE)**, and provide **services** where RIs from different domains are harmonized to deal with **scientifically and societally relevant topics**.

This **systemic approach** will support the Italian role in several RIs and help taking a leading role to address complex, multi-disciplinary challenges.

What is a Virtual Research Environment?

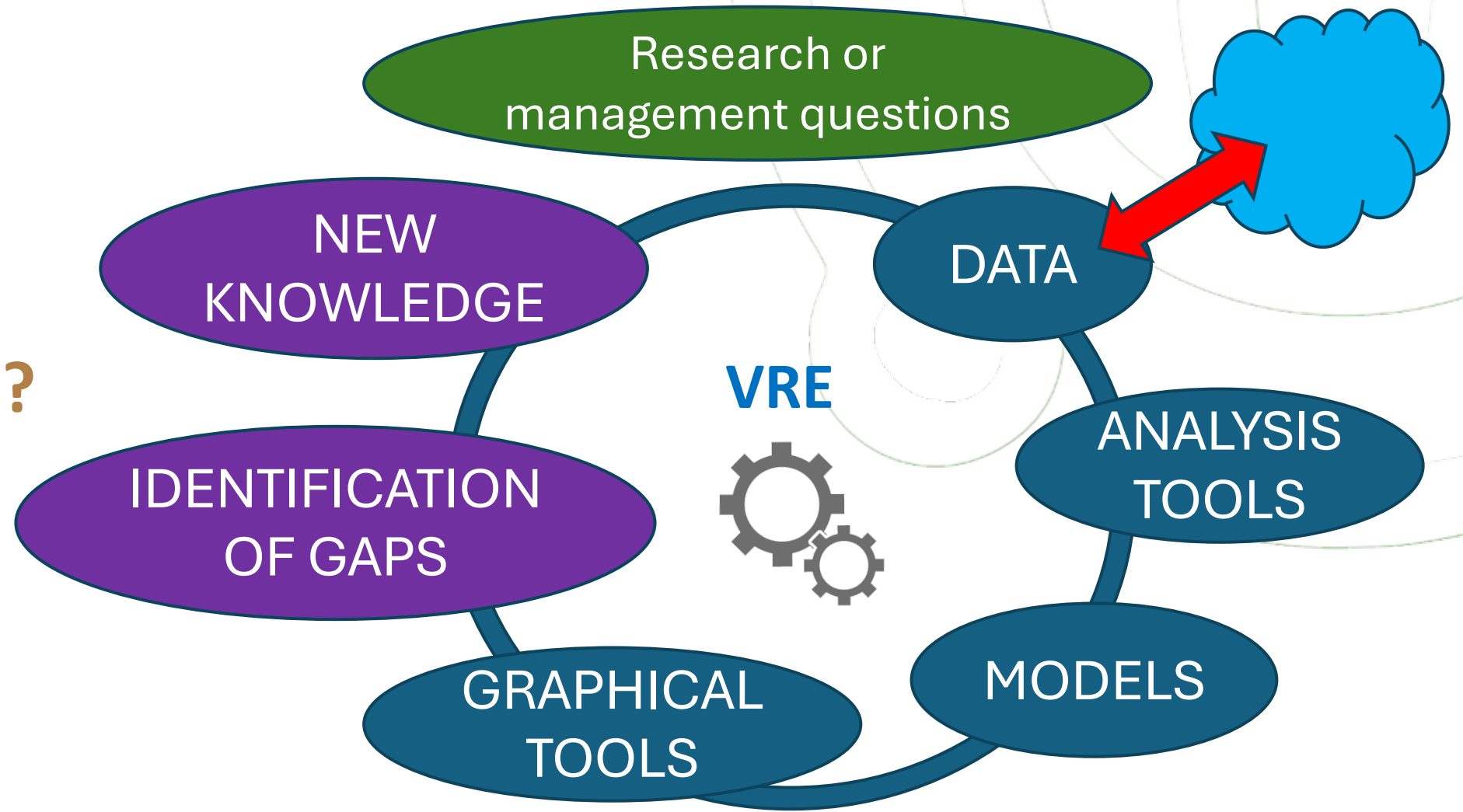
VRE



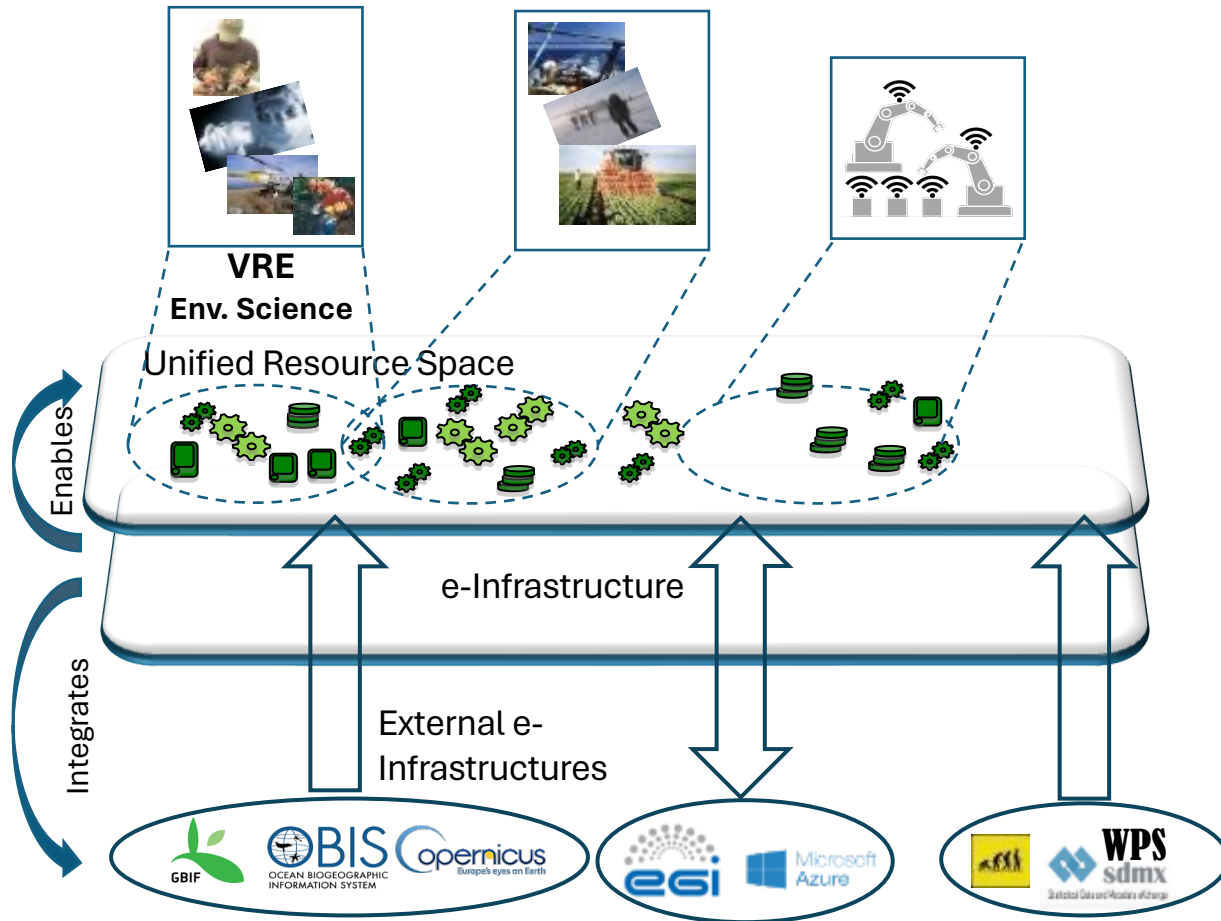
An e-Science online environment favouring collaborations and shared solutions **to answer specific scientific and/or management questions** that require an ensemble of data, analysis tools, modelling solutions and graphical tools, in the spirit of the **open science principles**.

Researchers can upload/download and share knowledge, contributing to the construction of the VRE. **Users** can access to a simplified version of the VRE to tackle specific issues.

What is a Virtual Research Environment?



The D4Science e-Infrastructure



A network of hardware and software resources (*databases, processes, services, machines, AI models*) that supports collaborative and data-intensive Science:

- Enables collaboration between researchers across countries;
- Researchers work together having shared access to the same facilities (data, instruments, computing, and communication).

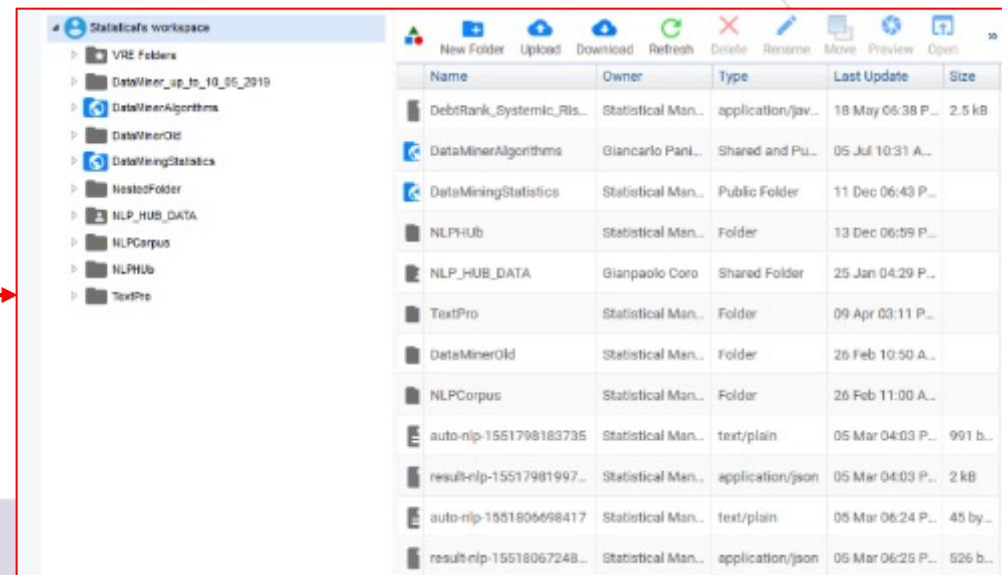
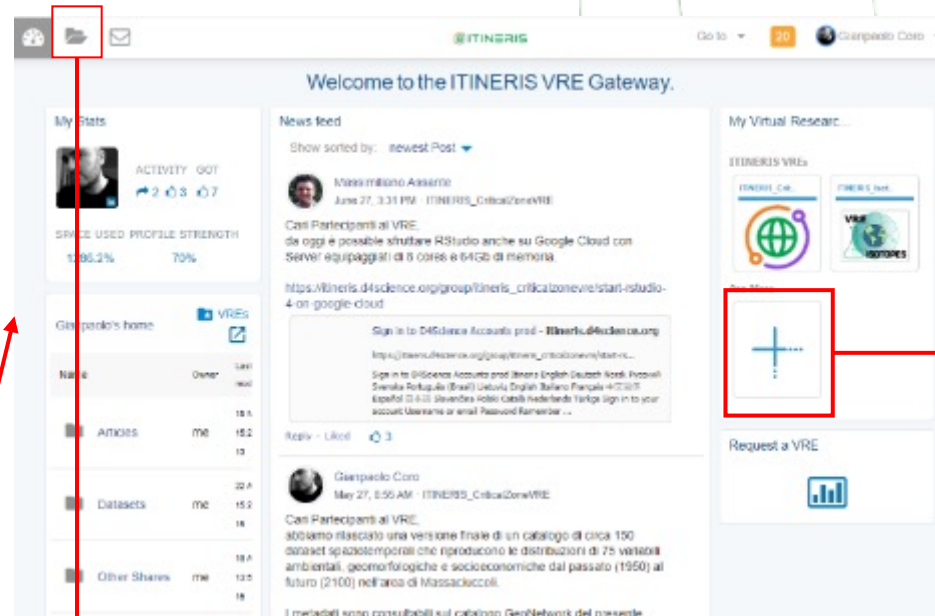
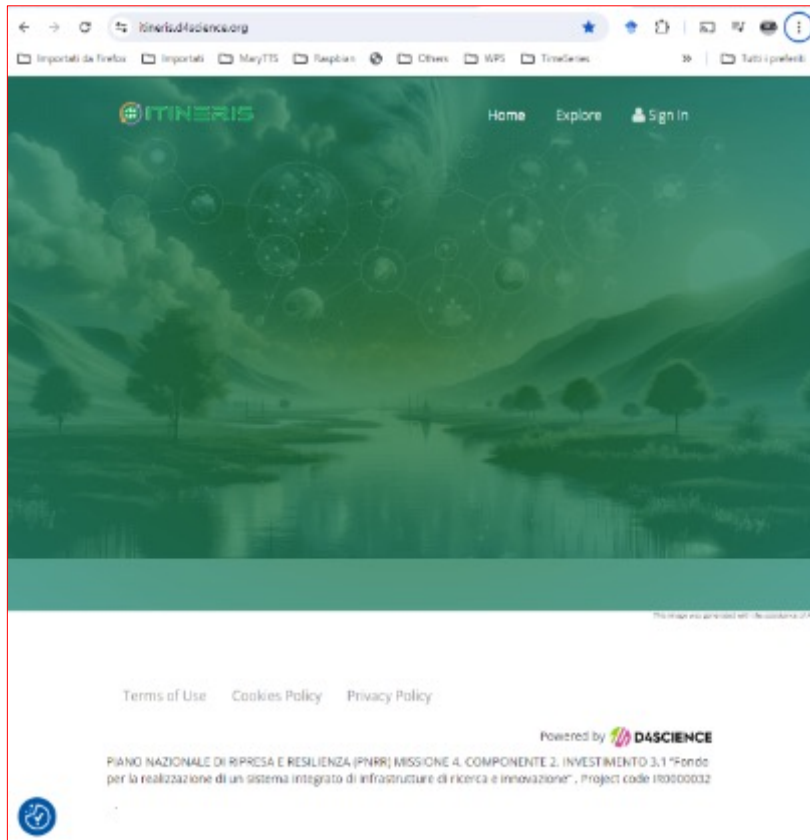
Supports the creation of **Virtual Research Environments** to:

- Define sub-communities of practice;
- Allow temporary dedicated assignment of computational, storage, and data resources;
- Manage heterogeneous data and processes access policies;
- Support data and information sharing;
- Allow sharing competences and creating multi-disciplinary applications.

The ITINERIS D4Science Gateway: itineris.d4science.org



1. A gateway to the D4S-based VREs
2. Allows to request access to VREs
3. Allows to upload files on the VREs and to the private users' workspace



The Critical Zone (CZ) VRE

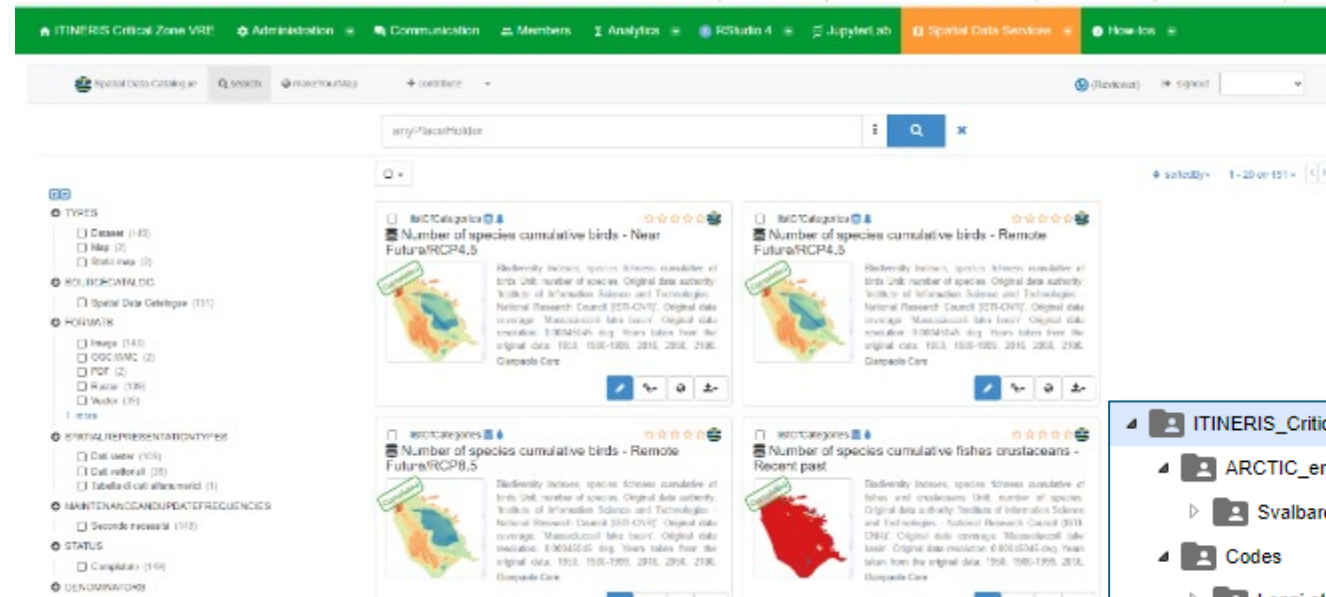


VRE manager: Pasquale Bove

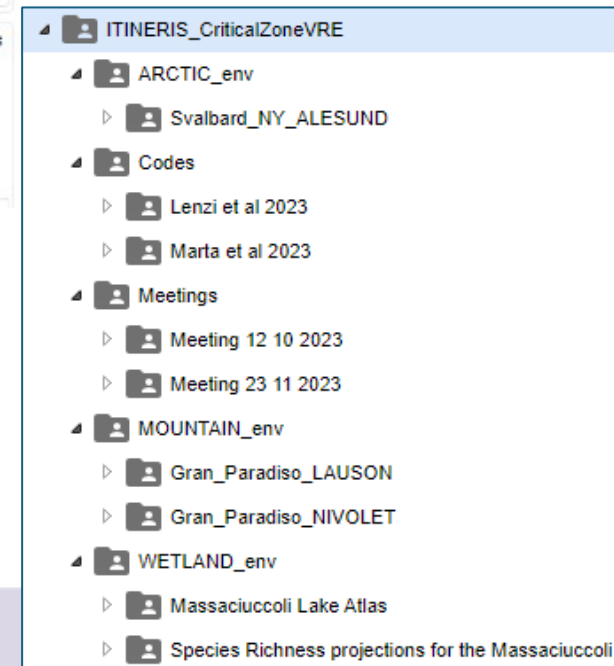
- 28 members
- 149 datasets published in the catalogue
- 11 processes and models available
- Social networking facilities

Machine and service types available for each user:

- RStudio: 4 Cores / 8G RAM (at Isti-Cnr)
- RStudio: 8 Cores / 32G RAM (at Isti-Cnr and on the Garr network)
- RStudio: 8 Cores / 64G RAM (on the Google Cloud connected to D4S)
- Linux/Python/Julia/Notebooks: 4 Cores / 16G RAM (at Isti-Cnr)



VRE Workspace organisation snapshot containing data available for all VRE members

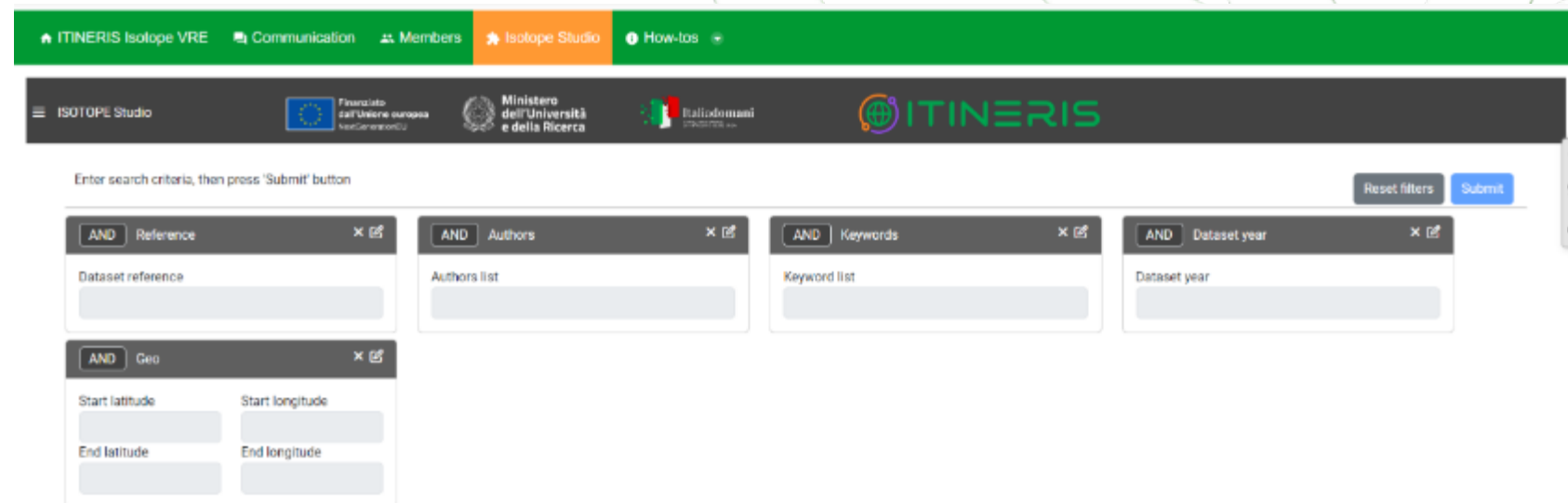


The Isotope VRE

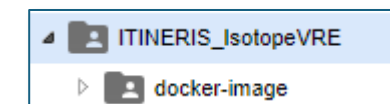


VRE manager: Eugenio Trumpy

- 13 members
- Hosts the first-ever **full-suite for isotope data management, manipulation, harmonisation, and analysis**
- Uses machines with 8 Cores / 32G RAM hosted by Isti-Cnr and on the Garr network



VRE Workspace organisation snapshot contains the docker image of the applications that all VRE members can download and use



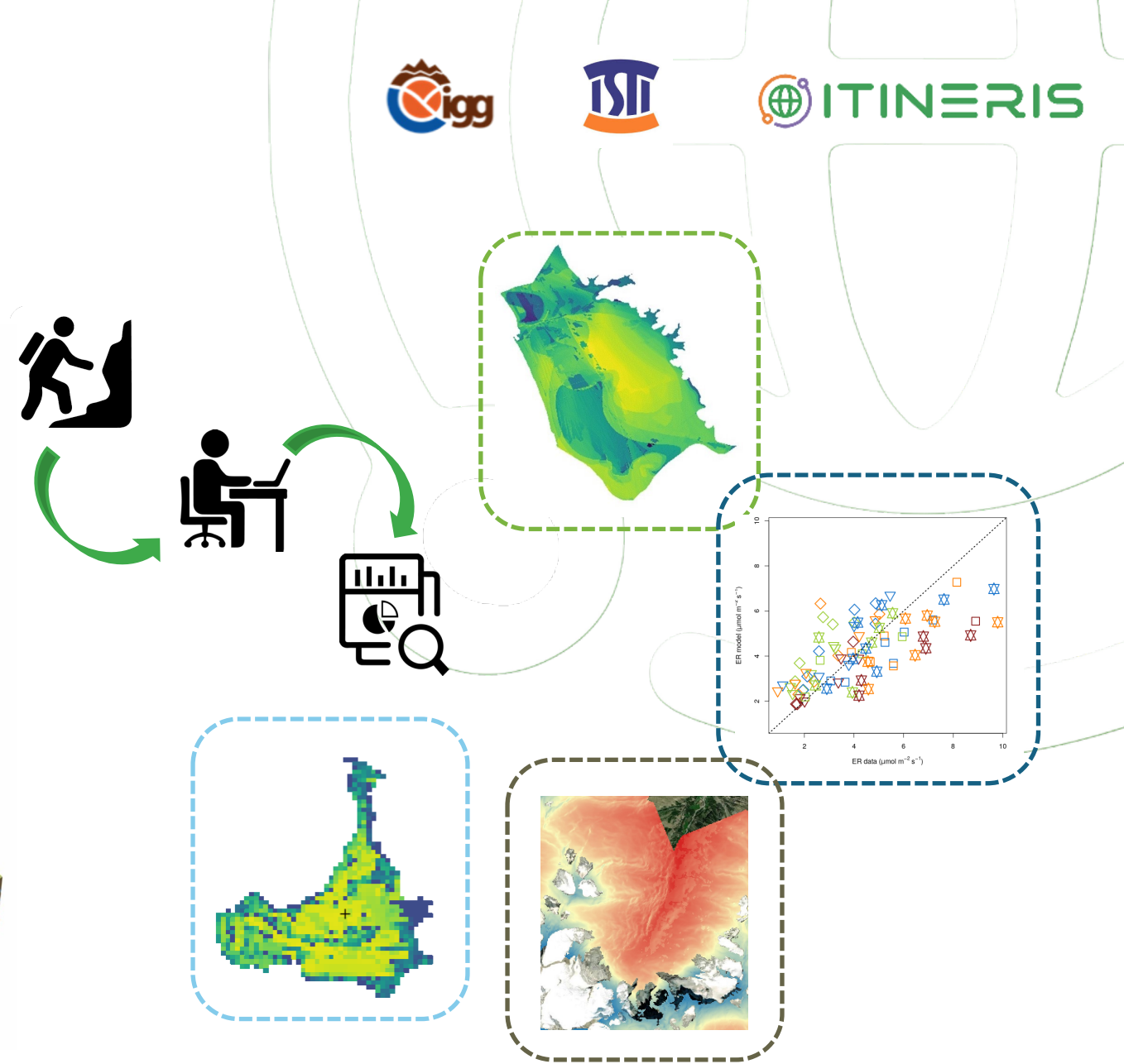
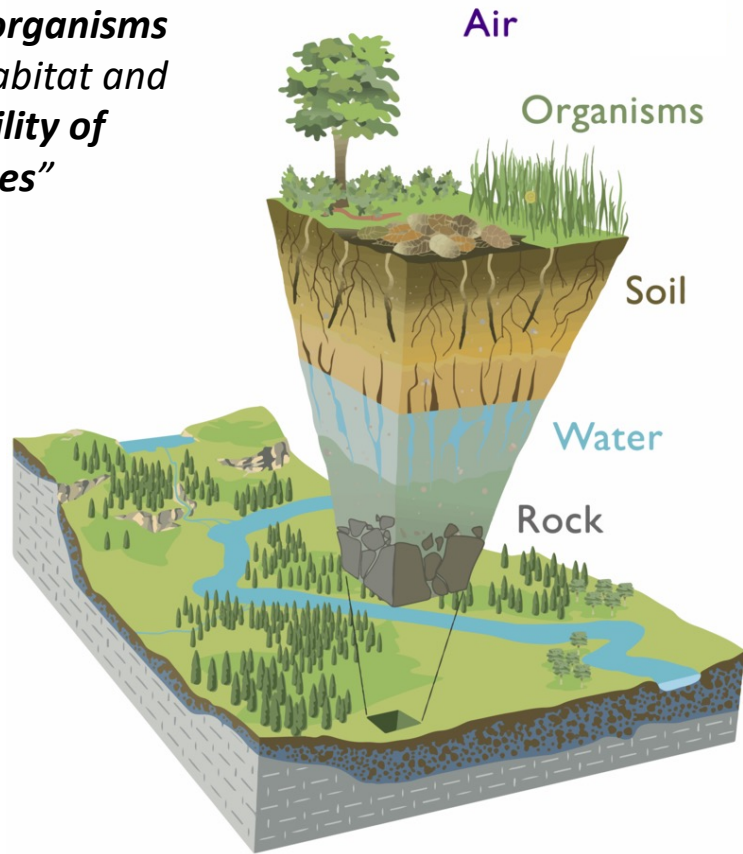
Critical Zone VRE

***Marta S., Gennaro S., Bove P., Caparrini F., Baneschi I.,
Coro G., Costanza L., D’Incecco S., Donato A., Forni P.,
Giamberini M. S., Menichini M., Pennisi M., Raco B.,
Vivaldo G. & Provenzale A.***

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”

Critical Zone VRE

“heterogeneous, near surface environment in which complex interactions involving rock, soil, water, air, and living organisms regulate the natural habitat and determine the availability of life-sustaining resources”
(NRC, 2001)





Data - Acquired & published

Portable flux chambers
(Nivolet CZO - PNGP - IT)

CO₂ fluxes (ER + NEE) / 2017-2023 / 3,590 records
Env: radiation + airT + airRH + soilVWC + soilT + pressure + coordinates

Portable flux chambers
(Ny Ålesund - Spitzbergen - NO)

CO₂ fluxes (ER + NEE) / 2019 / 248 records
Env: radiation + airT + airRH + soilVWC + soilT + pressure + GFC + coordinates

Eddy covariance tower
(IT-Niv - Nivolet CZO - PNGP - IT)

CO₂ flux (NEE) / 2020-2021 / 1,500 records
Env: airT + airRH + wind speed + wind dir + coordinates

Massaciuccoli basin - IT

Species distribution / 180 species / 6,540 records
Env: 148 high-res environmental, geomorphologic and socioeconomic datasets (75 variables - 1950 to 2100)



Data - Acquisition / publication in progress (embargoed)

Long-term monitoring
(Nivolet CZO - PNGP - IT)

CO₂ fluxes: portable chambers / 2017 - ongoing / summer - 15 days / 4,000+
CO₂ fluxes: automated chambers / 2022 - ongoing / summer - 1 rec h⁻¹ / 5,000+
CO₂ fluxes: eddy tower / 2019 - ongoing / summer - 2 rec h⁻¹ / 5,000+

Long-term monitoring
(Ny Ålesund - Spitzbergen - NO)

CO₂ fluxes: portable chambers / 2019 - ongoing / summer - on mission / 1,500+
CO₂ fluxes: eddy tower / 2019 - ongoing / yearly - 2 rec h⁻¹ / 15,000+
CO₂ fluxes: snowpack tower / 2024 - ongoing / 'winter' - 60 rec h⁻¹ / 0+

Continuous monitoring
(Etna CZO - IT)

CO₂ fluxes: portable chambers / 2021 - ongoing / on mission / 700+
CO₂ fluxes: automated chambers / 2021 - ongoing / yearly - 1 rec h⁻¹ / 10,000+
CO₂ fluxes: eddy tower / 2022 - ongoing / yearly - 2 rec h⁻¹ / 10,000+

Continuous monitoring
(Pianosa - PNAT - IT)

CO₂ fluxes: automated chambers / 2023 - ongoing / yearly - 4 rec h⁻¹ / 40,000+

Portable flux chamber
(CO₂ fluxes - various projects)

PNGP: Levionaz / Noaschetta / Lavessey / Dres /...(on mission / 500+)
GLORIA: M. Cimone / A. Mommio (on mission / 100+)
Delta Po: Bosco Mesola / yearly - 30 days / 200+

Codes - R

Fit of non-linear models for ER and GPP

- ✓ Perform a forward AIC-based model selection
- ✓ Summarize model outputs
- ✓ Plot observed-expected

Input: dataset (.csv) with flux measures and environmental variables

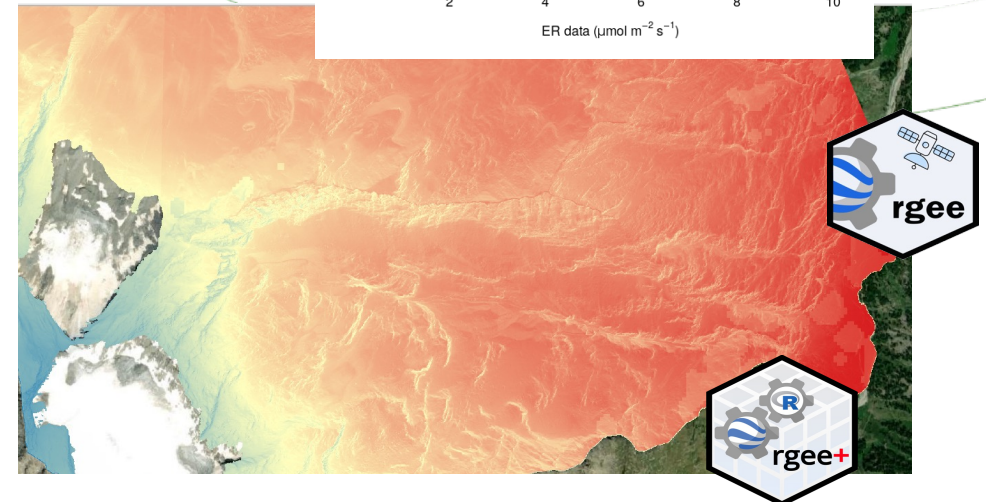
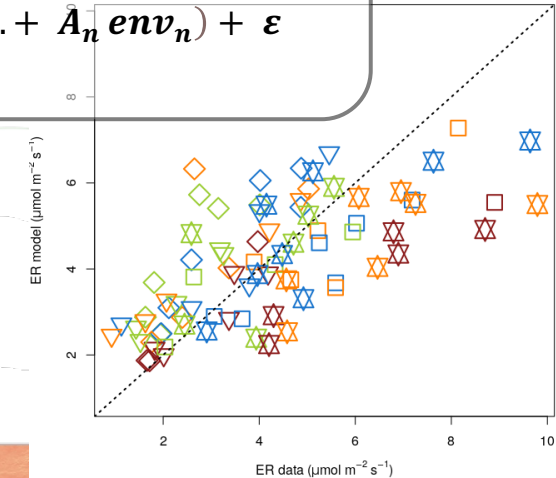
High-res soil microclimate in proglacial areas

- ✓ Integrate the Google Earth Engine platform
- ✓ Retrieve information (maps) on climate, potential sw radiation, snow-free season, permafrost occurrence, tree-shading
- ✓ Predict (map) monthly average soil temperature

Input: DEM, glacier outline(s), selection on the period of interest (Y, M)

$$ER = e^{b_0 T} (a_0 + a_1 env_1 + \dots + a_n env_n) + \varepsilon$$

$$GPP = \frac{\alpha_0 rad}{1 + \frac{\alpha_0}{F_0} rad} (A_1 env_1 + \dots + A_n env_n) + \varepsilon$$



Critical Zone VRE

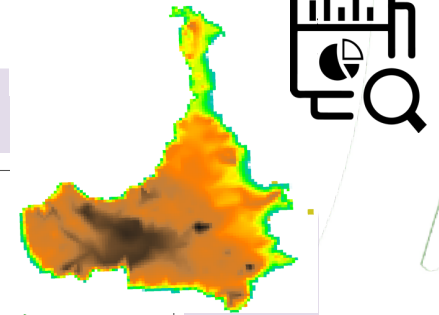
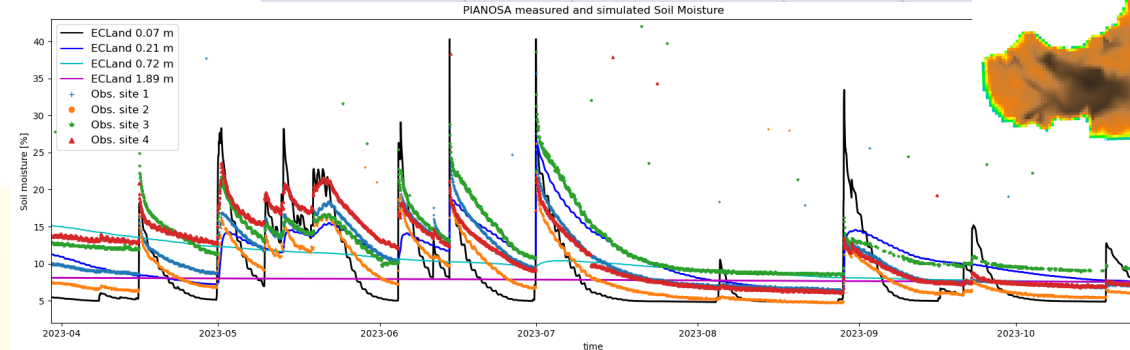
Codes - Fortran / Python (in progress)



CHTESSEL / ECLand

- ✓ Model land-atmosphere fluxes (H₂O, CO₂,...)
- ✓ Predict soil moisture

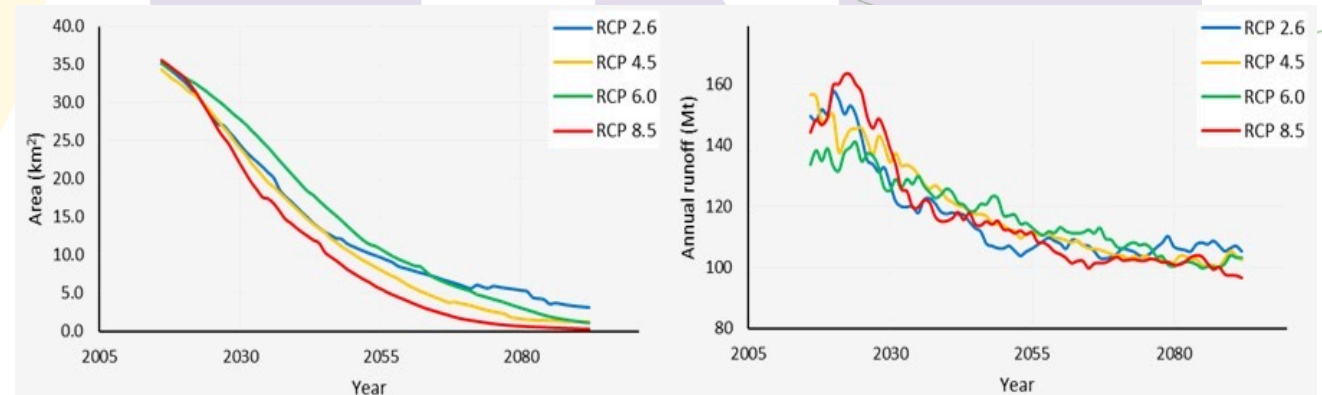
Input: Precipitation, radiation, wind speed, pressure, airT, airRH



Open Global Glacier Model

- ✓ Run-off trends under different RCP scenarios
- ✓ Prediction of glacier snout position

Input: DEM, glacier outline(s)



Stakeholders



Projects



Effects of Global Warming on Aquatic Biomass and Phytoplankton Production

- VRE : Investigation of the temporal variation of Chl-a and net primary production in the aquatic component in relation to temperature

Scientific coordinator: Prof. Alberto Basset

Working group: Teodoro Semeraro, Jessica Titocci, Flavio Monti, Lorenzo Liberatore, Francesco De Leo,
IRET-URT Lecce, CNR

Data of VRE

🌐 Field data

➤ Chl-a



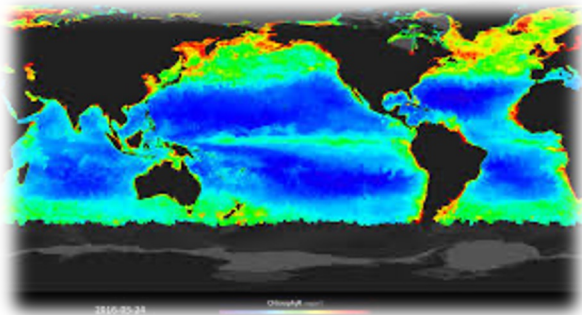
➤ Sea Temperature



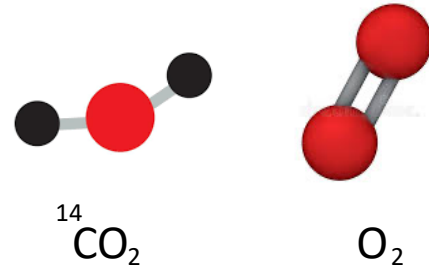
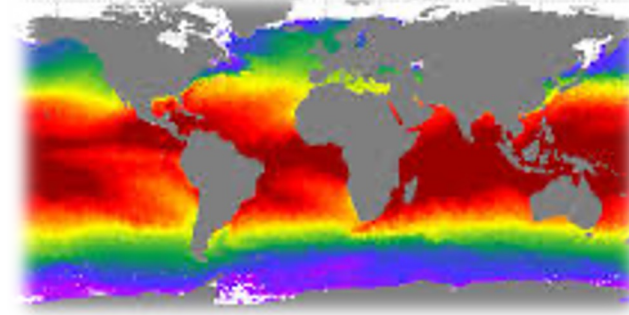
➤ Net Primary Production

🌐 Remote Sensing Data

MODIS *Chl-a*



MODIS SST



Prototype development on Datalabs:

**DataLabs: LifeWatch's Collaborative Coding Platform for
Biodiversity and Ecosystem Research**


<https://datalabs.lifewatchitaly.eu/dashboard/ui/home>


 Workflow 1: Assessment of Chl-a and NPP variations in relation to the thermal gradient.
Application of linear regression and random forest models to field data



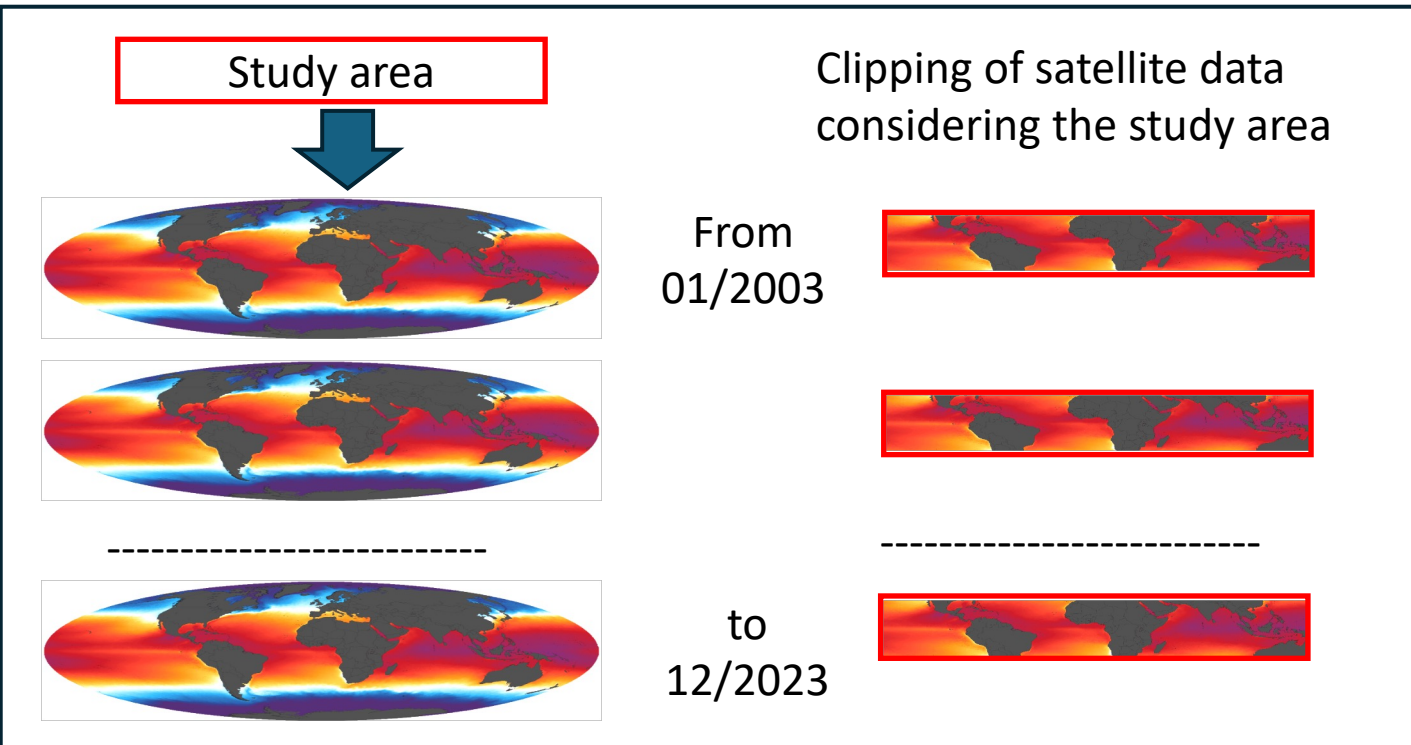
Calibration of Net Primary Production field data resulting from ^{14}C based analytical methods and from model estimates based on satellite imagery



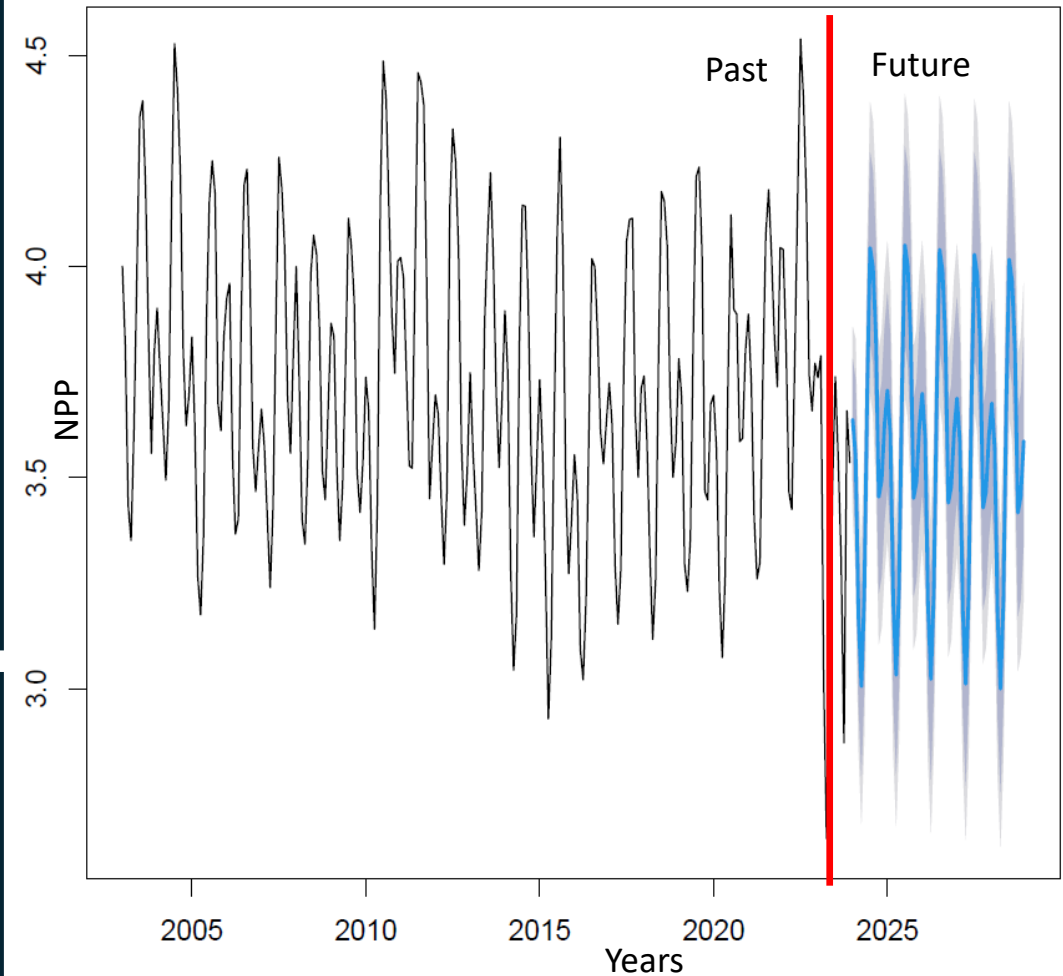
 Workflow 2 & 3: Assessment of Chl-a and NPP variations in relation to the thermal gradient.
Application of linear regression and random forest models to remote sensing data for the development SST, Chl-a and NPP time series and make their projection in time.

 Workflow 4: The use of remote sensing data to assess the spatial correlation between SST and Chl-a, and the temporal projection of Chl-a in relation to SST variability.

Tools Implemented in the WFs



Temporal projection of time series of SST, Chl-a and NPP

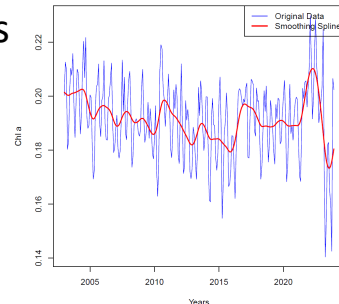


Definition of a good regression model and its application to satellite data in order to obtain new products:

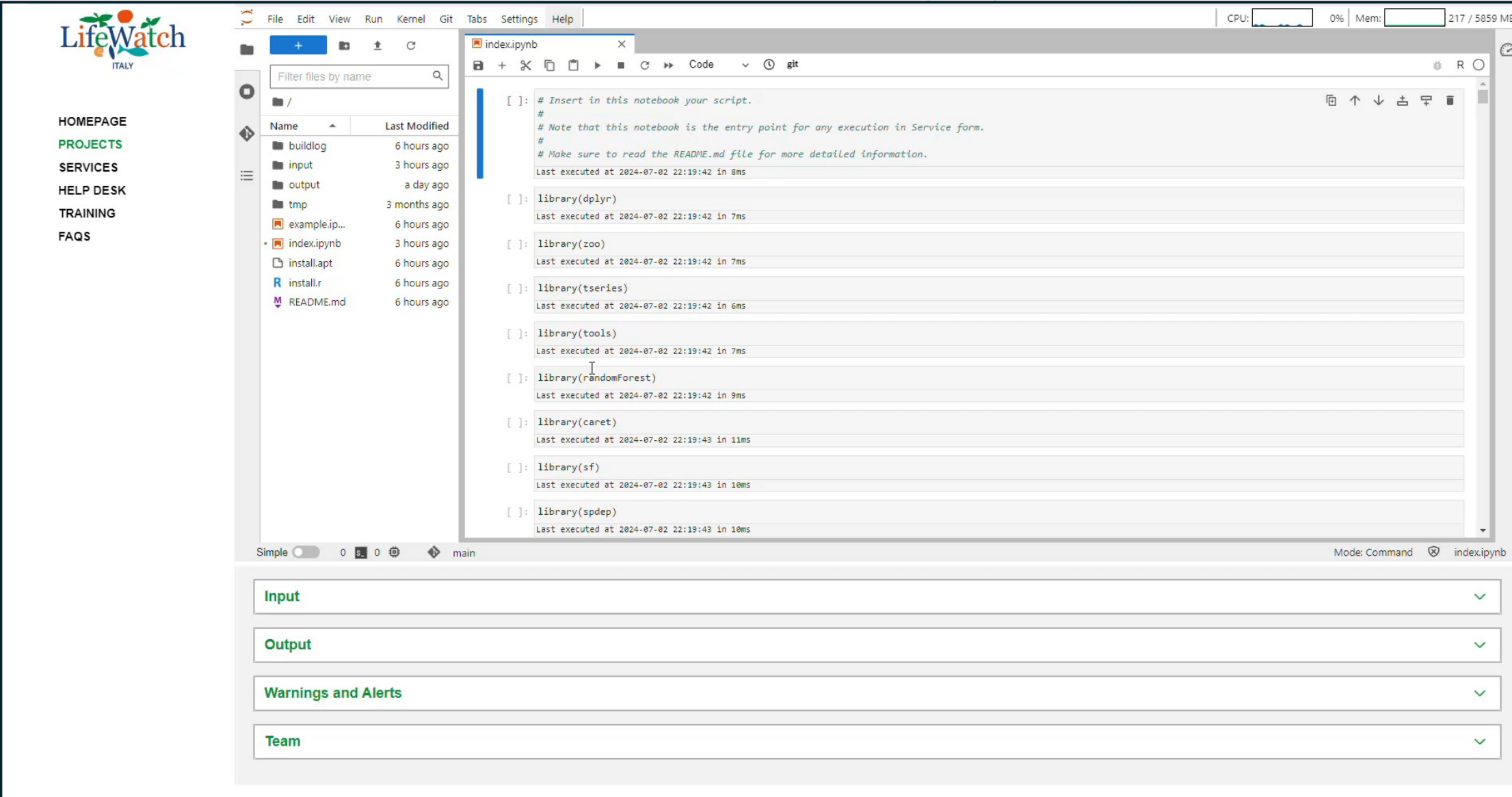
- NPP
- Chl-a

Realization of time series and perform statistical analysis on:

- SST
- Chl-a
- NPP



E.g. Workflow 2



The screenshot displays the LifeWatch ITALY JupyterLab environment. On the left, a sidebar contains navigation links: HOMEPAGE, PROJECTS, SERVICES, HELP DESK, TRAINING, and FAQs. Below these is a file browser showing a directory structure with files like buildlog, input, output, tmp, example.ip..., index.ipynb (selected), install.apt, install.r, and README.md, along with their last modified times.

The main workspace shows a notebook named 'index.ipynb' with the following R code cells:

```
[ ]: # Insert in this notebook your script.  
#  
# Note that this notebook is the entry point for any execution in Service form.  
# Make sure to read the README.md file for more detailed information.  
Last executed at 2024-07-02 22:19:42 in 8ms  
  
[ ]: library(dplyr)  
Last executed at 2024-07-02 22:19:42 in 7ms  
  
[ ]: library(zoo)  
Last executed at 2024-07-02 22:19:42 in 7ms  
  
[ ]: library(tseries)  
Last executed at 2024-07-02 22:19:42 in 6ms  
  
[ ]: library(tools)  
Last executed at 2024-07-02 22:19:42 in 7ms  
  
[ ]: library(randomForest)  
Last executed at 2024-07-02 22:19:42 in 9ms  
  
[ ]: library(caret)  
Last executed at 2024-07-02 22:19:43 in 11ms  
  
[ ]: library(sf)  
Last executed at 2024-07-02 22:19:43 in 10ms  
  
[ ]: library(spdep)  
Last executed at 2024-07-02 22:19:43 in 10ms
```

At the bottom, there are four expandable sections: Input, Output, Warnings and Alerts, and Team, each with a downward arrow.

VRE applications and utilities

Who is it for:

- Researchers who work with field or laboratory data and want to try to apply/spread their study at a higher spatial-temporal scale.
- Economists and Planners who can use prospective analysis to build scenarios in their studies.

Time saved:

- It provides a basic approach for those without remote sensing skills, with a time saving of around 2-3 months.
- Without programming skills, a researcher would need at least 3-4 months to develop the codes.
- The first approach to the study of time series can take about 1-3 months to acquire the necessary scientific knowledge
- Economic Savings

Performance

- It is possible to run the calculation process on a PC that is not very powerful. All you need is a connection.
- Processing takes many hours and can be carried out without the PC being switched on.
- Avoid using software whose licence is not free.





IRET Montelibretti: Gaia Vaglio Laurin, Alessandro Sebastiani, Paolo Sconocchia

IRET Porano: Francesca Chiocchini, Gabriele Guidolotti, Olga Gavrichkova

IRET Lecce: Flavio Monti, Teodoro Semeraro, Jessica Titocci, Lorenzo Liberatore

IRET Firenze: Alessandro Montagni

The first digital environment for
Carbon-related data and dynamics.

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
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VRE CARBON



VRE C aims:

- Storing spatially explicit C-related datasets to promote data sharing, analysis, innovative research
- Providing tools for on-demand geospatial analyses
- Facilitating reporting activities for administrations (end user-oriented)



Target data:

- variables from large-scale models
- ground observations
- modeling results

The Carbon VRE integrates:

- Harmonized and georeferenced data on ecosystems carbon dynamics
- Re-elaborated emission data
- Tools and facilities for independent analyses
- Field data
- Modeling

Name	Owner	Last modified
C_flux_model ...	me	15 Feb 12:05 24
Emissions_It ...	me	08 Jun 10:25 24
Field data	AS	08 Jun 14:28 24

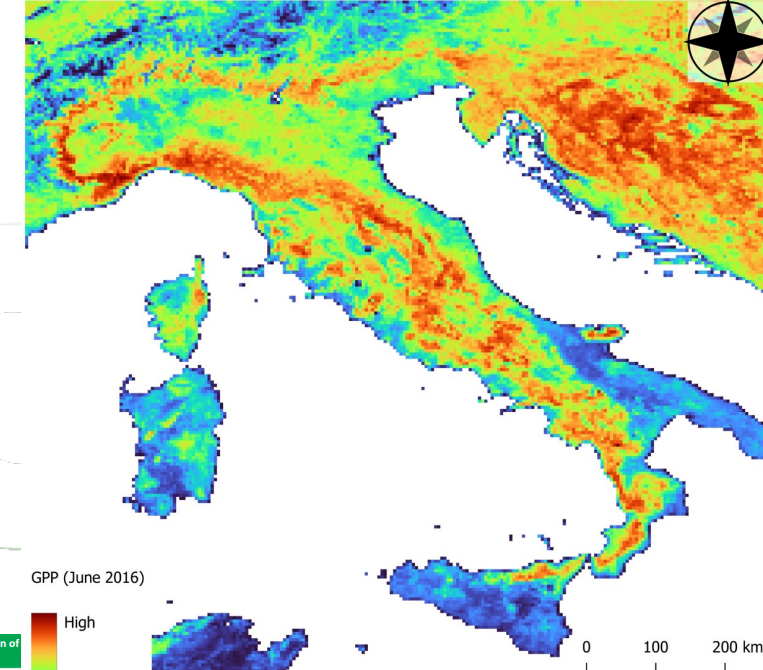
Harmonized ecosystem C dynamics for Italy

GPP, NEE, Ra data, from main flux-based models:

- spatial resolution > 0.05°, in agreement with Italian landscape fragmentation
- Harmonization includes monthly aggregation for several years
- Model comparison and infographics

Now including 3 families and 144 monthly products:

- Fluxnet Ensemble Modeling products
- Vegetation Photosynthesis and Respiration Model
- Vegetation Photosynthesis model



*Now in workspace,
to be uploaded in
Geoserver*

**Other models to be
soon included!**

Shared Folder	
ITINERIS Carbon / C_flux_models_Italy	
Name	Owner
FLUXCOM ensemble products	AS
Vegetation Photosynthesis and Respiration Model	me
Vegetation Photosynthesis Model	AS

A global moderate resolution dataset of Gross Primary Production of

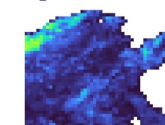
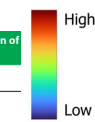
The VPM dataset contains 17 raster stacks for Gross Primary Productivity (GPP), derived by further processing and aggregation of the Vegetation Photosynthesis Model (VPM) products. Each stack has 12 layers, one per month.

The unit is Mg * ha⁻¹ * month⁻¹. The coordinate reference system is WGS84 (EPSG: 4326). Spatial resolution is equal to 0.05° (roughly 4.3 km x 5.3 km). This dataset provides estimates of GPP, at a moderate resolution for the period from 2000 to 2016. GPP measures the amount of carbon dioxide that plants convert into biomass through photosynthesis.

The VPM offers a refined approach to estimating GPP by focusing on the absorption of light by chlorophyll and incorporating factors that affect leaf quality and environmental conditions. It addresses limitations of traditional the Light Use Efficiency (LUE) models, providing a more accurate and dynamic representation of vegetation productivity at various scales. The VPM algorithm uses:

- Satellite Data, such as MODIS (Moderate Resolution Imaging Spectroradiometer) or other sources
- Climate Data: Incorporates climate variables from reanalysis datasets (e.g., temperature, precipitation) to adjust LUE for environmental conditions.
- Land Cover Classification: Uses land cover data to apply biome-specific parameterizations in the model.
- GPP estimates are validated against flux tower measurements across various biomes and geographic regions to ensure reliability.

GPP (June 2016)



Esempio di mappa



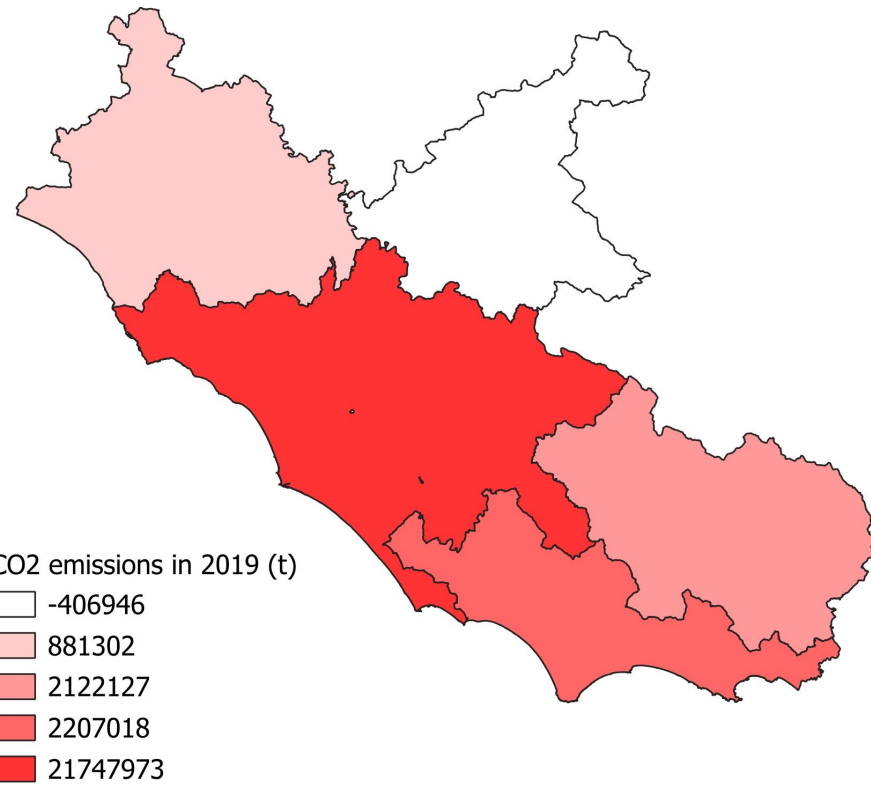
Esempio di grafico

Citation: Zhang, Yusi, Xiao, Xiangming, Wu, Xiaocui, Zhou, Sha, Zhang, Geli, Qin, Yuanwei, et al. (2017). A global moderate resolution dataset of gross primary production of vegetation for 2000-2016. EartharXiv Collection. <https://doi.org/10.6084/m9.figshare.c.3789814.v1>
To access the original data: http://figshare.com/collections/A_global_moderate_resolution_dataset_of_gross_primary_production_of_vegetation_for_2000-2016/3789814 Data source: CC BY 4.0

GHG emissions

Spatially explicit data, derived from national GHG tabular inventory

- spatialization of main GHG at Province
- source characterization
- grouped by time intervals since 1990



Field data



Different IRET groups are collecting ground new data on **grasslands** for calibration and validation of above ground biomass experimental models, based on SAR + optical remote sensing and machine learning

Modeling

Data/results from experimental research and models.

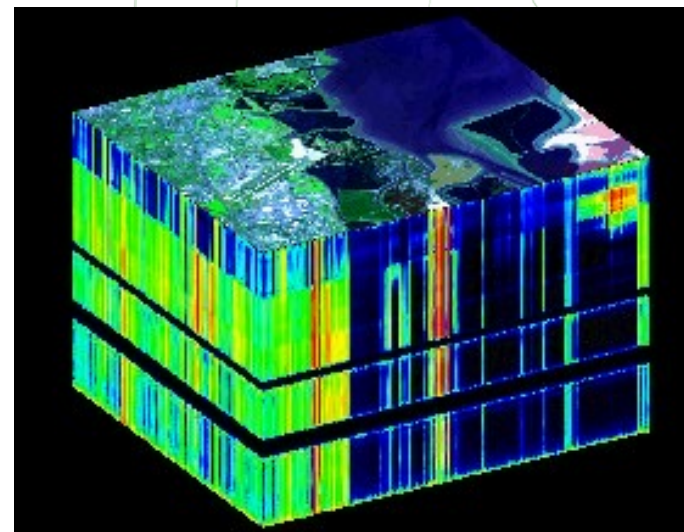
Example:

Ecosystem Functional Properties (EFPs) and Hyperspectral imagery

-WUE, LUE, and GPP are EFPs that help in explaining the ecosystems functioning

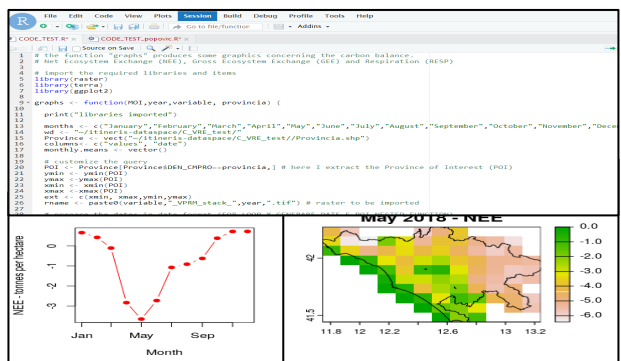
-EFPs are derived from the ICOS research infrastructure

-EFP are linked to PRISMA hyperspectral data to explore the capability to predict ecosystem functioning from space.



Tools

R script to customize data processing and extract information





Data plotting and modelling based on Element Ratios and Isotopic Composition using ITINERIS Isotope VRE and the capabilities of Isotope Studio

Paolo Di Giuseppe CNR-IGG (Pisa)

Erico Perrone CNR-IGG (Pisa)

Simona Gennaro CNR-IGG (Pisa)

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Nothing is more effective for understanding the nature of your data than seeing a plot



Isotope Community



Data Modelling



VREs Cooperation



Data Upload

Data Upload

Data Querying

Explore External Sites

Georeferenced Data

Data Plotting

Data Modelling

The screenshot shows the ISO TOPE Studio interface. At the top, there are logos for the European Union, the Italian government, and the ITINERIS project. The main area is titled "Dataset list" and contains a "Dataset upload" form. The form includes fields for "Dataset reference (DOI or other link)" (https://doi.org/10.1016/j.jhydrol.2020.125850), "Year of paper publication" (2021), "Author(s)" (Doveri, Marco; Natali, Stefano; Franceschi, Linda; Menichini, Matia; Trifirò, Sandra; Giannecchini, Roberto), and "Keywords" (Carbonate aquifers; water isotopes). There is a "Choose a file" button and a file named "DoveriETA(2021)_Table2.xlsx" is selected. The form also has "Cancel" and "Submit" buttons.

Journal of Hydrology 593 (2021) 125850

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)



Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol








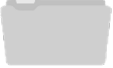
Research papers

Carbonate aquifers threatened by legacy mining: hydrodynamics, hydrochemistry, and water isotopes integrated approach for spring water management

Marco Doveri^a, Stefano Natali^{a,b,c,*}, Linda Franceschi^{a,c}, Matia Menichini^a, Sandra Trifirò^a, Roberto Giannecchini^{a,c}

^a IGG-CNR, Institute of Geosciences and Earth Resources, via Moruzzi 1, 56124 Pisa, Italy
^b Department of Earth Sciences, University of Florence, via G. La Pira 4, 50121 Florence, Italy
^c Department of Earth Sciences, University of Pisa, via S. Maria 53, 56126 Pisa, Italy



-  Data Upload
-  **Data Querying**
-  **Explore External Sites**
-  Georeferenced Data
-  Data Plotting
-  Data Modelling

Enter search criteria, then press 'Submit' button

Reset filters **Submit**

AND Reference ✕ ✎

Dataset reference

AND Authors ✕ ✎

Authors list

AND Keywords ✕ ✎

Keyword list

AND Dataset year ✕ ✎

Dataset year





AND Geo ✕ ✎

Start latitude Start longitude

End latitude End longitude

Data Querying





Explore External Sites

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Dataset list

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Georeferenced data report







By authors **By locations** By polygon

DI GIU	DI GIUSEPPE	N
29229	DI GIUSEPPE	N
29177	DI GIUSEPPE	N

Selected: **DI GIUSEPPE P.**

Downloading data

Processed 5 items of 183 ○

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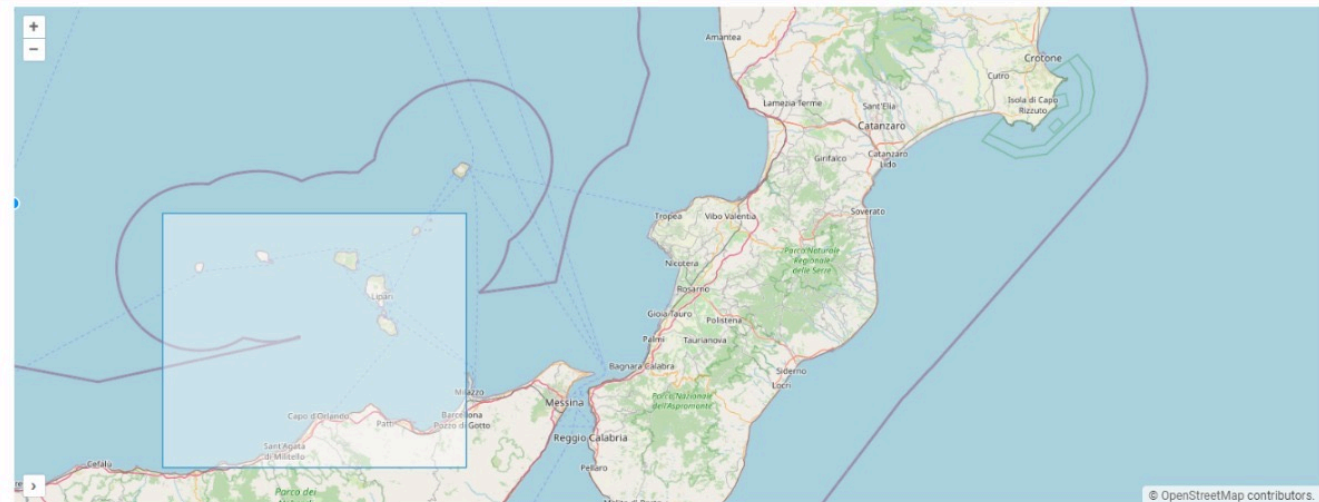
Use the mouse for navigate and zoom the map. Press the SHIFT key + LEFT mouse button to draw a rectangular selection on the map.

Top coordinates:

latitude longitude

Bottom coordinates:

latitude longitude



Lat. 38.7071 : Long. 13.7411

20 km

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ITINERIS_ID	GEOROC_ID	LATITUDE	LOCATIONS	LONGITUDE	SAMPLE NAME	K [WT%]	AGE [MA]	Al2O3 [WT%]	CaO [WT%]
19936	63933	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:MONTE PALMIERI FORMATION:	14.58	FIL53II	1.14			
19937	63934	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:MONTE PALMIERI FORMATION:	14.58	FIL35I	1.35			
19938	63935	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:MONTE PALMIERI FORMATION:	14.58	FIL35II	1.21			
19939	63936	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:MONTE PALMIERI FORMATION:	14.58	STR170	1.08	0.19		
19940	63937	38.58	AEOLIAN ARC:FILICUDI(ITALY):FILO DEL BANCO FORMATION:FOSSA DELLE FELCI(ITALY):ITALY:	14.58	FIL123	0.88	0.39		
19941	63938	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:	14.58	FIL83	1.93	0.23		
19942	63939	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:	14.58	STR171	2.19	0.19		
19927	59157	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:	14.58	F10C			0.89	21.04
19928	59158	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:	14.58	F9C			2.12	21.18
19929	59170	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:	14.58	F15C			1.17	20.6
19930	59171	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:	14.58	F19C			3.8	21.76
19931	59185	38.58	AEOLIAN ARC:FILICUDI(ITALY):FOSSA DELLE FELCI(ITALY):ITALY:	14.58	F8C			3.77	22.32

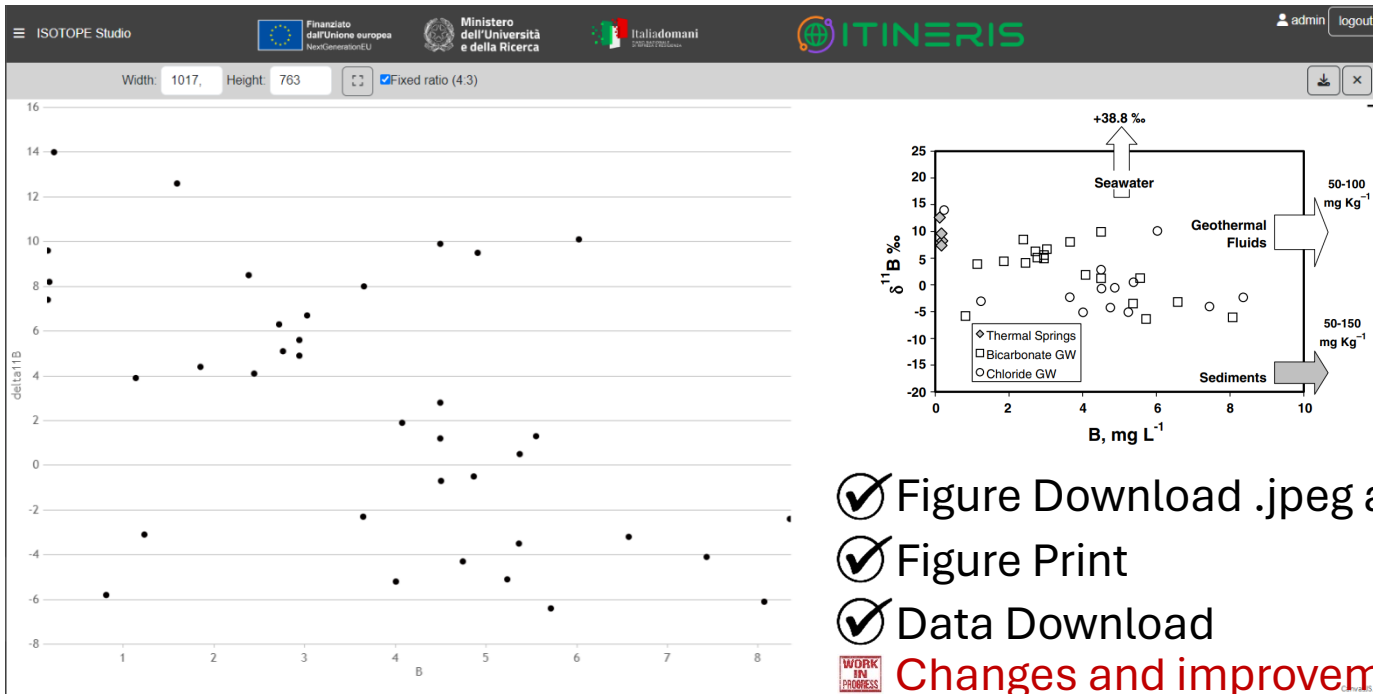
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- Data Plotting**
- Data Modelling

- Binary Plot**
- Ternary Plot
- Normalised Diagrams

Data from Pennisi et al (2006)_Applied Geochemistry

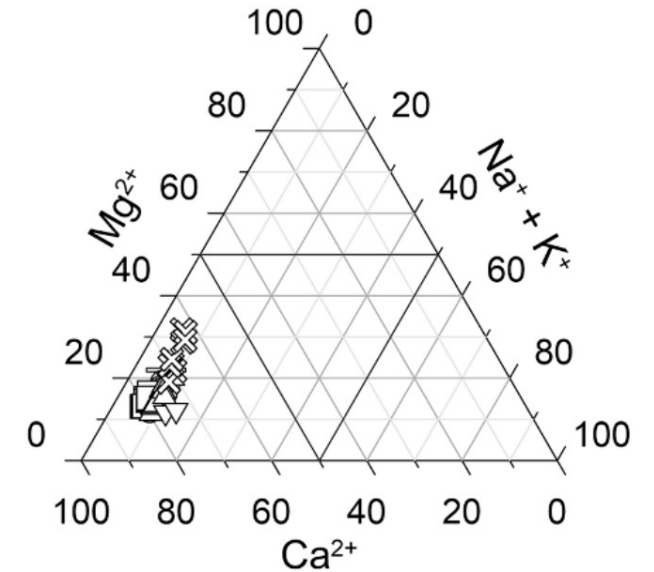
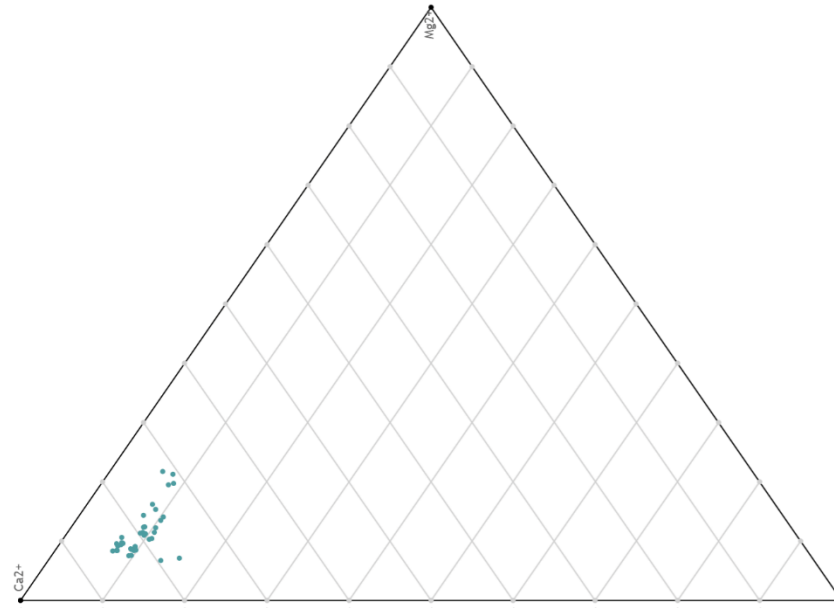
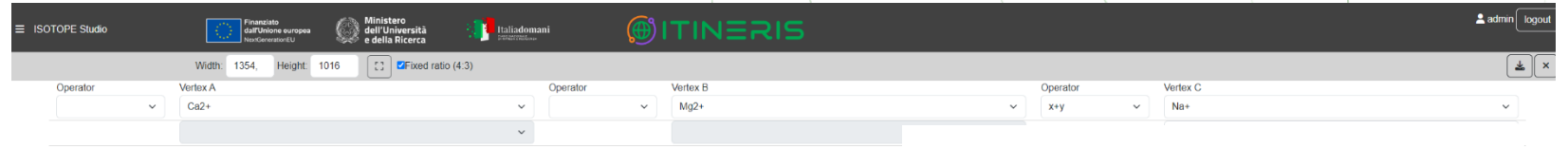


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Changes and improvements are planned

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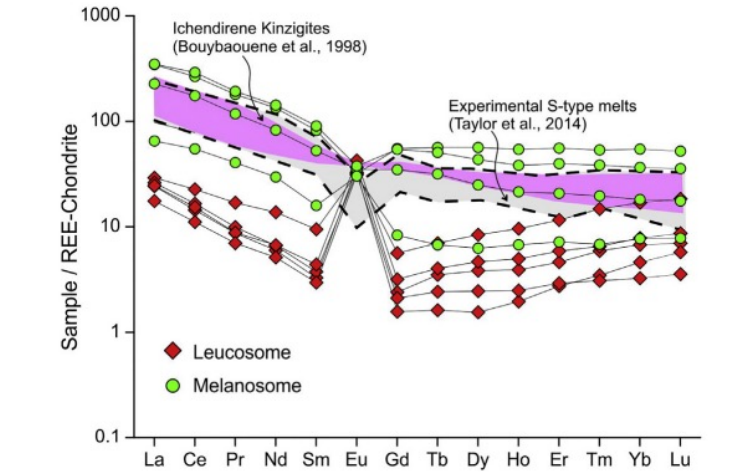
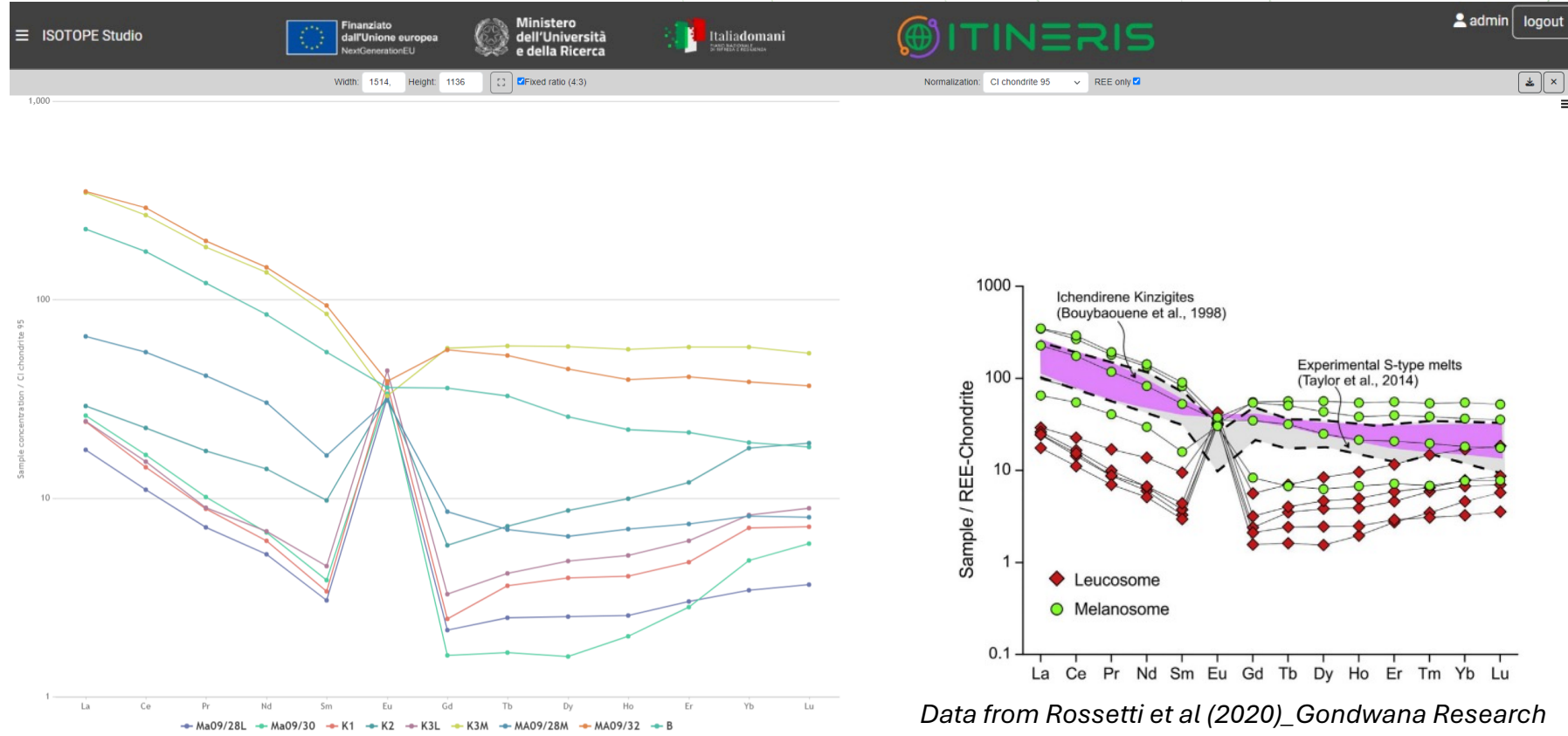
Data from Doveri et al (2021)_Journal of Hydrology

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Data from Rossetti et al (2020)_Gondwana Research

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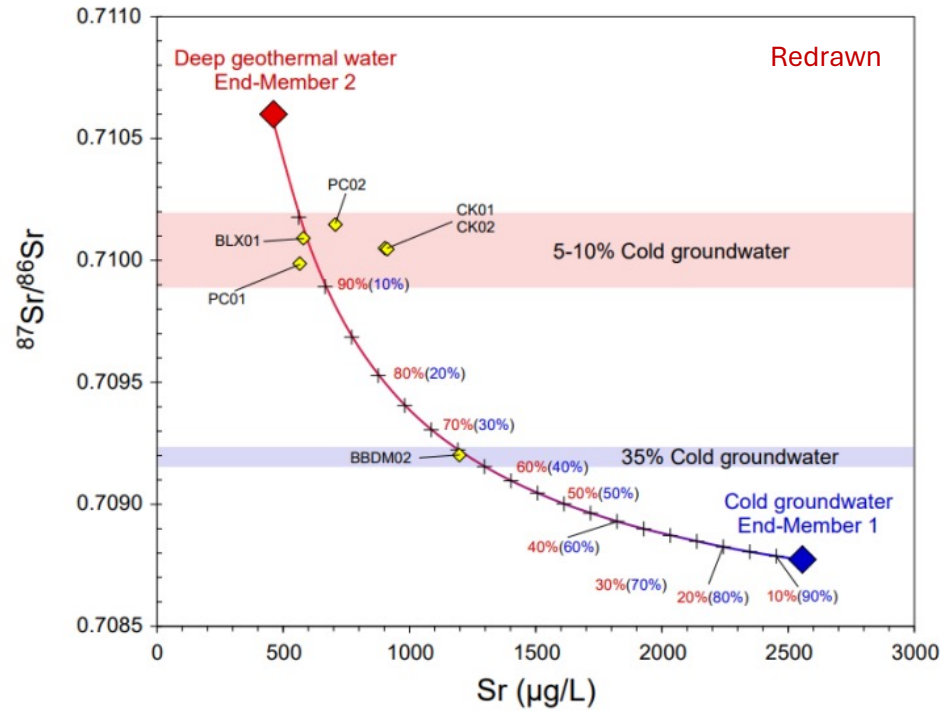
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-  Data Plotting
-  **Data Modelling**

-  **Binary Mixing**
-  Ternary Mixing

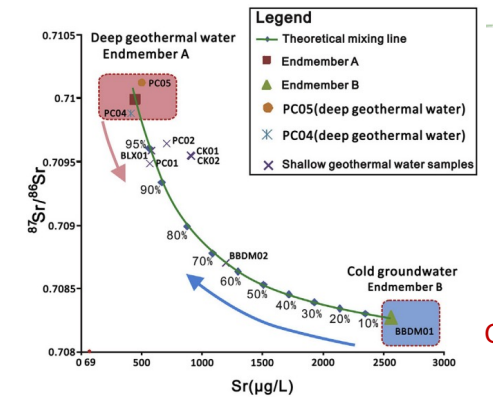


Example of Data Download

SR	87SR86/SR	BBDM01: 87SR/86SR	Average PC04-PC05: 87SR/86SR
456	0.710005	0.000	1.000
561	0.709609	0.050	0.950
666	0.709339	0.100	0.900
771	0.709142	0.150	0.850
877	0.708992	0.200	0.800
982	0.708874	0.250	0.750
1087	0.708780	0.300	0.700
1192	0.708701	0.350	0.650
1297	0.708636	0.400	0.600
1402	0.708580	0.450	0.550
1508	0.708532	0.500	0.500
1613	0.708491	0.550	0.450
1718	0.708454	0.600	0.400
1823	0.708422	0.650	0.350
1928	0.708393	0.700	0.300
2033	0.708367	0.750	0.250
2138	0.708344	0.800	0.200
2244	0.708323	0.850	0.150
2349	0.708304	0.900	0.100
2454	0.708286	0.950	0.050
2559	0.708270	1.000	0.000



Di Giuseppe et al (2023)_CNR Internal Report










Original

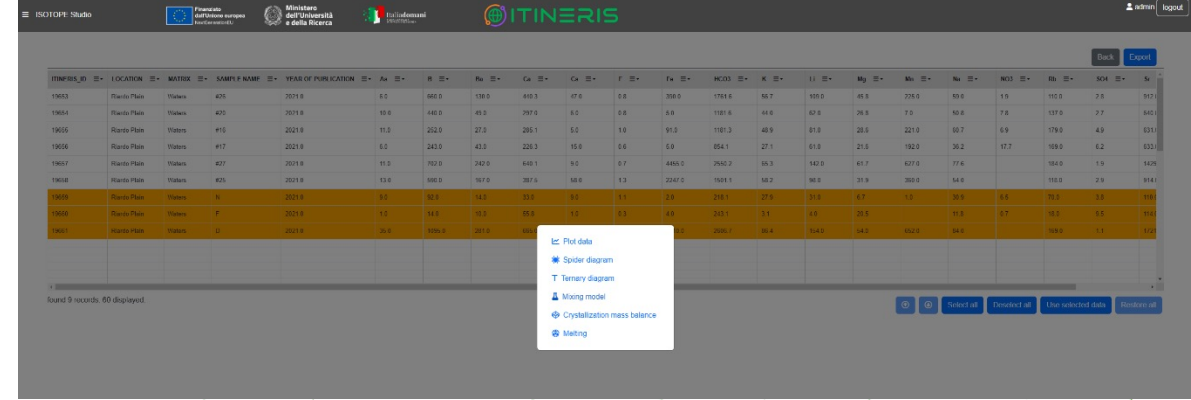
Data from Wang et al (2020)_Geoscience Frontiers

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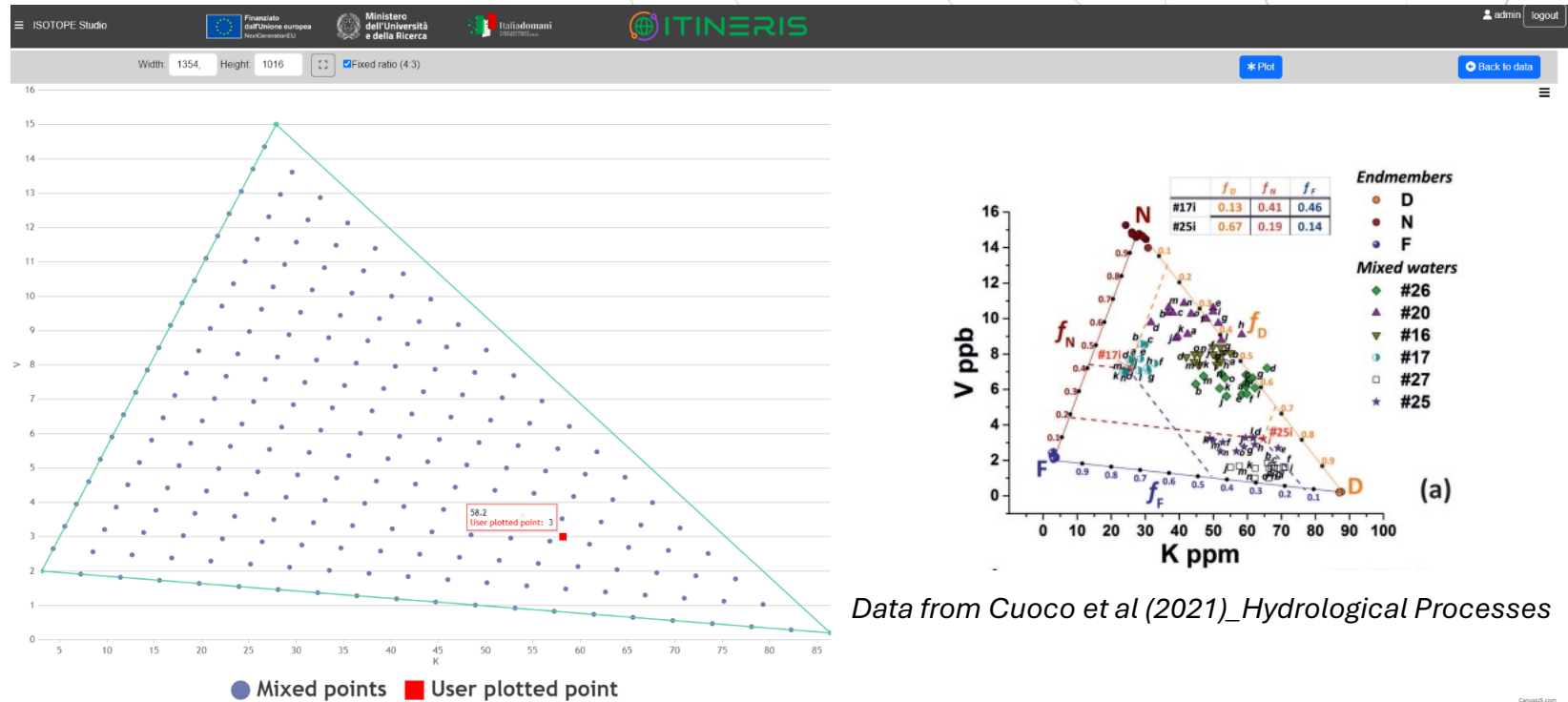
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-  Data Plotting
-  Data Modelling

-  Binary Mixing
-  Ternary Mixing






SAMPLE_ID	LOCATION	MATRIX	SAMPLE_NAME	YEAR OF PUBLICATION	Ar	R	Ra	Ca	Ca	F	Fa	NC00	K	Li	Mg	Na	NO3	NO4	SO4		
19053	Rivolo Plan	Water	476	2021	0.2	462.0	136.0	410.3	17.6	2.8	208.0	1741.4	50.7	105.0	16.8	275.6	50.6	1.6	102.0	2.7	840.1
19054	Rivolo Plan	Water	475	2021	0.6	440.0	41.0	297.0	8.0	0.8	5.8	101.6	44.6	42.0	26.8	7.0	40.8	7.8	137.6	2.7	840.1
19055	Rivolo Plan	Water	#16	2021	0.1	252.0	27.0	285.1	5.0	1.0	91.0	1101.3	40.9	0.18	20.6	221.0	10.7	6.9	179.0	4.9	831.1
19056	Rivolo Plan	Water	#17	2021	0.0	243.0	43.0	228.3	15.6	0.6	0.9	85.1	27.1	0.18	21.6	192.0	36.2	17.7	189.0	6.2	833.1
19057	Rivolo Plan	Water	#27	2021	0.1	702.0	242.0	640.1	9.0	0.7	4886.0	2962.2	16.3	142.0	41.7	627.0	77.6	184.0	1.9	1428.1	
19058	Rivolo Plan	Water	#25	2021	0.3	986.0	197.0	397.6	18.0	1.3	2247.0	1031.1	18.2	163.1	31.9	383.0	54.8	110.0	2.9	914.1	
19059	Rivolo Plan	Water	5	2021	0.2	323.0	143.0	323.0	9.1	1.1	2.3	218.7	27.9	31.0	6.7	1.3	30.9	6.5	75.1	1.3	910.1
19060	Rivolo Plan	Water	F	2021	1.0	143.0	10.0	10.0	1.0	0.3	4.8	243.1	3.1	4.0	20.0	11.0	6.7	18.0	1.0	102.0	
19061	Rivolo Plan	Water	D	2021	0.0	1000.0	2010.0	1000.0	0.0	0.0	0.0	2000.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sample	Results	N	F	D
	Isotope Studio	0.15	0.25	0.59
#25	Cuoco Et al. (2021)	0.16	0.24	0.60
	EMMA	0.16	0.24	0.58
	Isotope Studio	0.43	0.41	0.16
#17	Cuoco Et al. (2021)	0.44	0.41	0.15
	EMMA	0.44	0.41	0.15
	Isotope Studio	0.38	0.09	0.53
#26	Cuoco Et al. (2021)	0.41	0.08	0.51
	EMMA	0.41	0.05	0.53



Data from Cuoco et al (2021)_Hydrological Processes

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 Changes and improvements are planned



THANKS!

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