



Alplakes

BACKGROUND

Science vs. Alternative Facts: What Drives Society?

Our mission as environmental scientist

Knowledge development

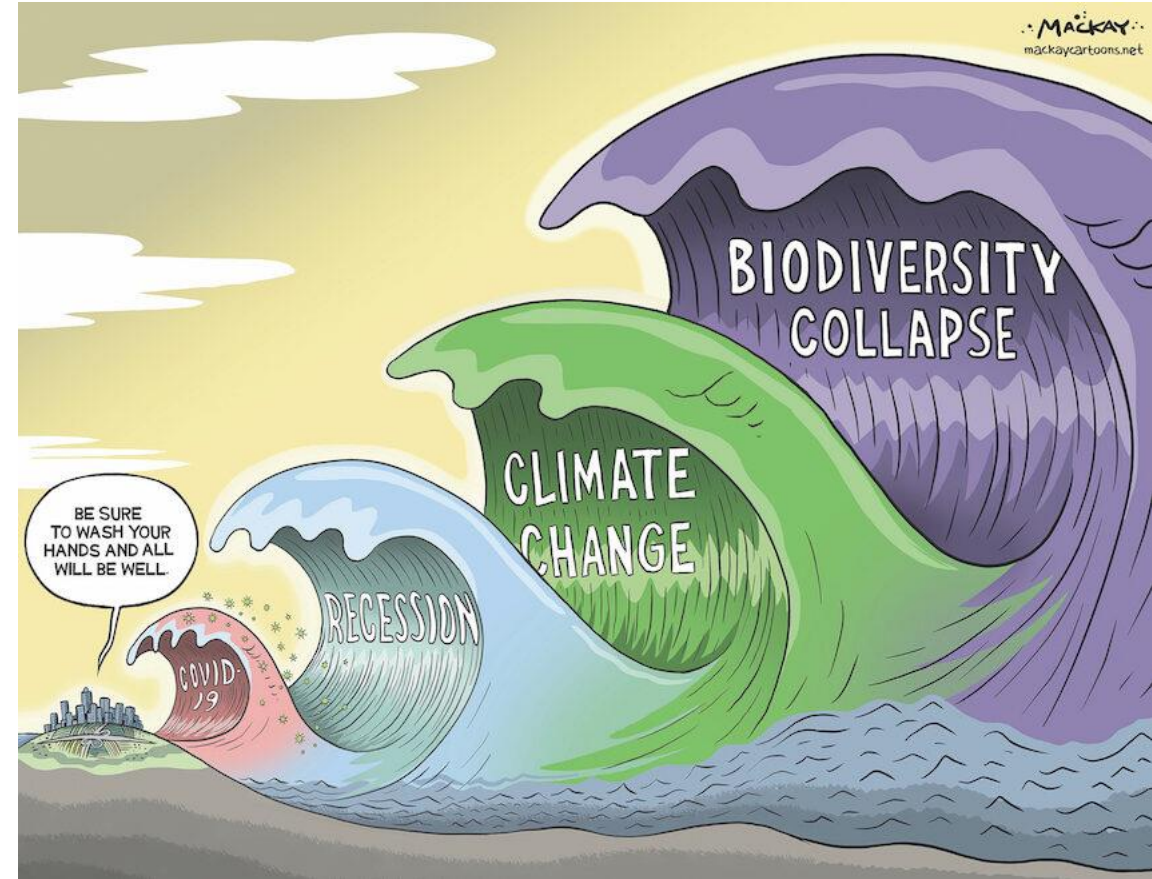
- Documenting changes
- System & process understanding

Actionable knowledge

- Converting scientific findings into practical solutions
- Developing evidence-based recommendations

Knowledge transfer

- Translating complex scientific products into understandable information
- Training
- Advising policymakers and stakeholders
- Engaging with the public
- Sharing best practices



Are we meeting our mission goals efficiently?

BACKGROUND

Problem formulation

Lakes are indicators of watershed health

Additional practical challenges

- 1 planet but 1.4×10^6 lakes (Hydrolakes)
- 1.4×10^6 lakes = 1.4×10^6 different study sites?
- 1.4×10^6 lakes = 1.4×10^6 different methods?
- 1.4×10^6 lakes = 1 limnology community?

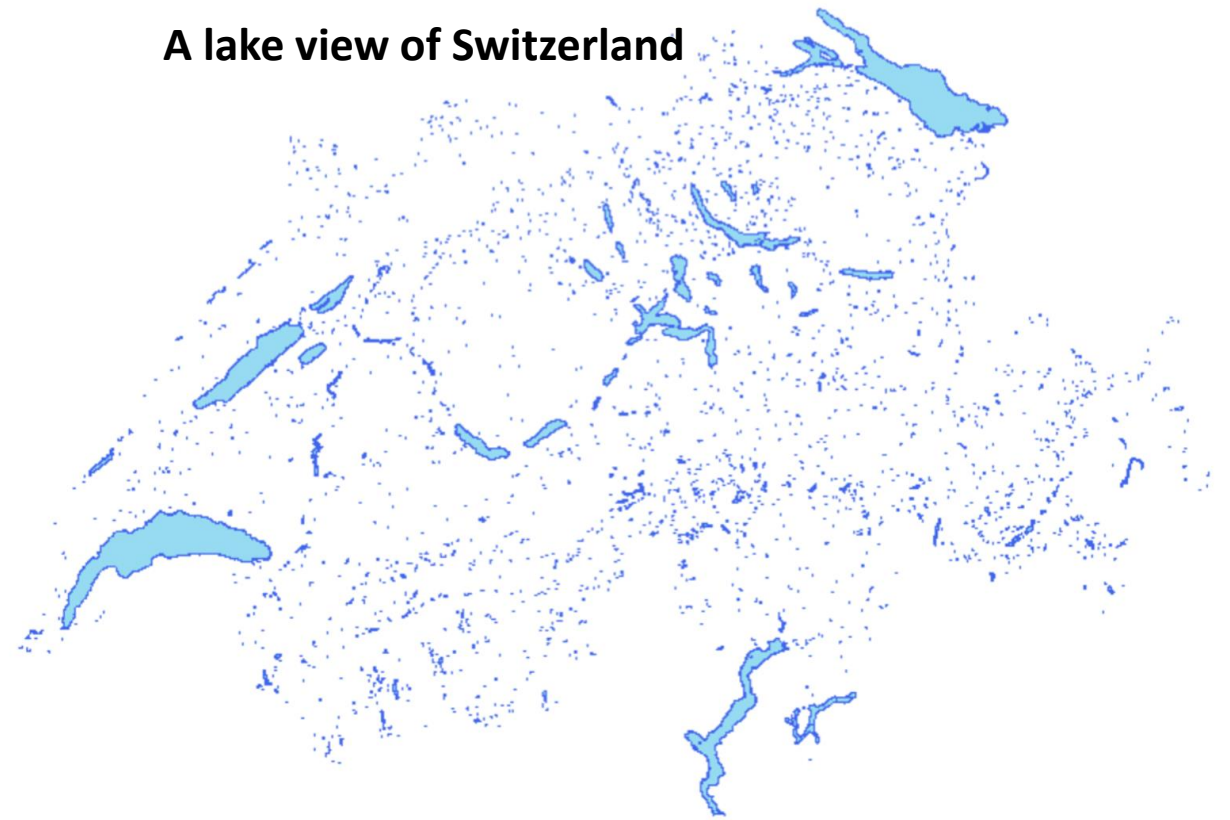
Problem formulation

- We need to join forces. Progress from one group should more explicitly benefit to the other groups.
- Collaborations exist but often lack efficient design for real benefit

Examples of success

- GLEON
- ISIMIP
- ...

A lake view of Switzerland



BACKGROUND

Problem formulation

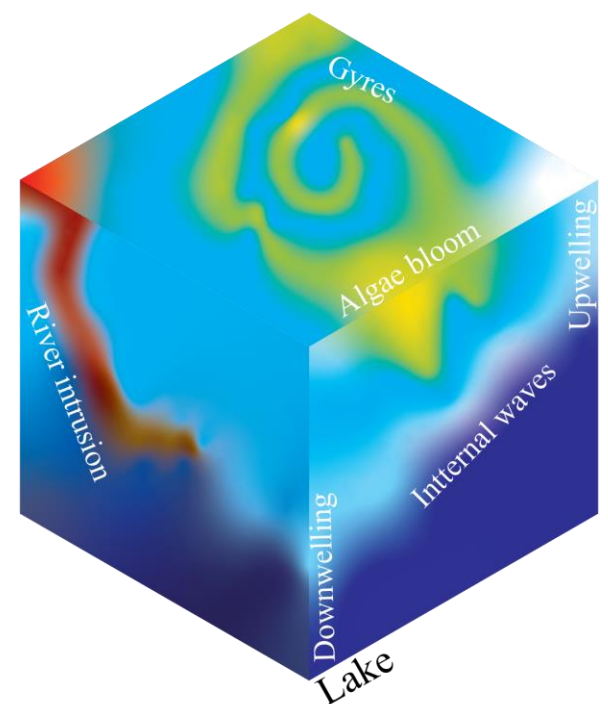
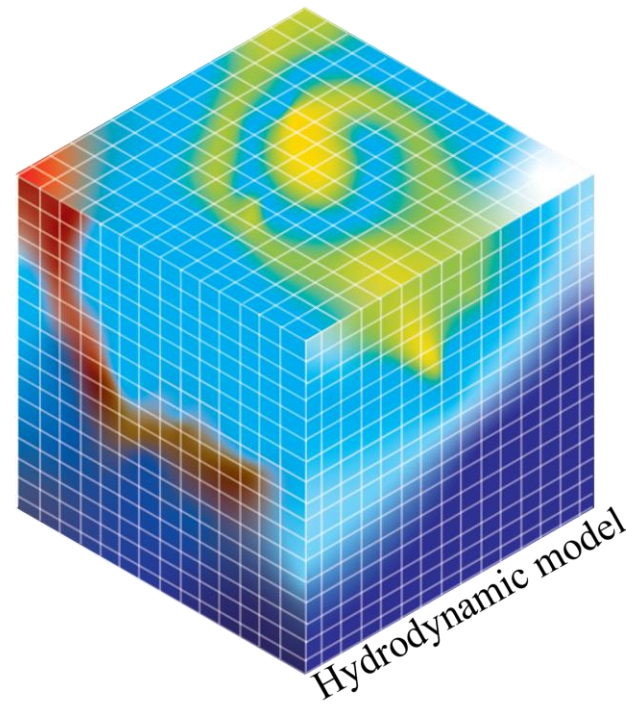
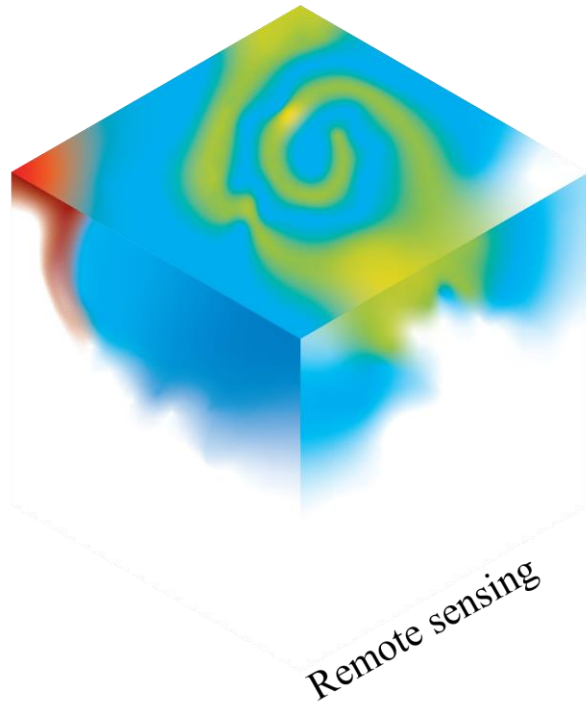
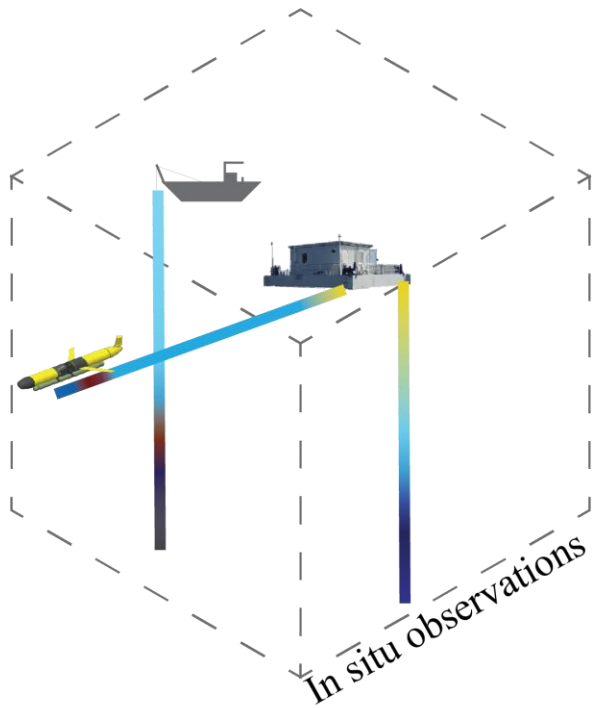
QUESTION

How can we combine different information sources to better understand lake ecosystems?

How can we make this tool helpful for scientific research and environmental management?

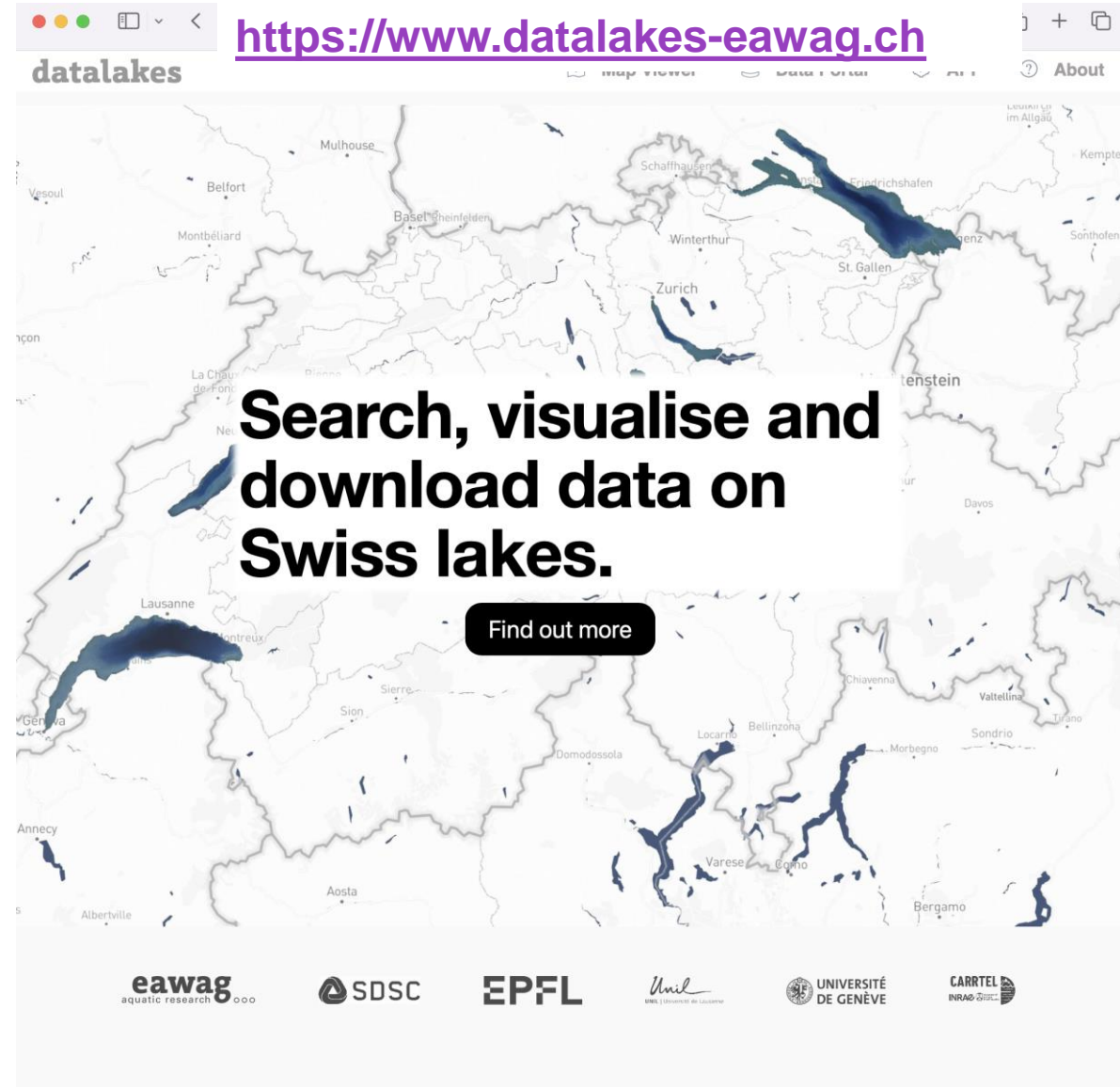
Alplakes

Goal – toward a regional product for (peri) alpine lakes



PART I In-situ observations

Example of initiative: DATALAKES



<https://www.datalakes-eawag.ch>

Search, visualise and download data on Swiss lakes.

Find out more

eawag aquatic research 000 SDSC EPFL Unil UNIVERSITÉ DE GENÈVE CARTEL INRAE

A data pipeline for lakes data

Motivations:

- To provide a web interface to data
- To favor visualisation to avoid downloading TB of (useless) data
- To make the data products fully reproducible.
- To promote collaboration
- To promote outreach

PART I In-situ observations DATALAKES at a Glance

The screenshot shows the 'Data Portal' section of the Datalakes website. It features a search bar at the top with the text 'Search using keywords e.g. ctd or geneva or salinity'. Below the search bar, there are three dataset cards:

- LéXPLORE Wave Buoy**: Live surface wave information from the wave buoy at the LéXPLORE floating platform. (LéXPLORE Core Dataset). Parameters: Wave Height, Wave Period, Wave Direction.
- Buchillon Field Station**: Live, real time environmental data from the Buchillon Field Station. Parameters: Water temperature, Air Temperature, Solar Irradiance, Rainfall, Relative Humidity, Dew Point, Wind Speed, Wind Direction.
- LéXPLORE Temperature Chain**: Live water temperature data from the temperature chain at the LéXPLORE floating platform. (LéXPLORE Core Dataset). Parameters: Water temperature, Surface temperature, Bottom temperature, Mixing depth, Thermocline Depth, Schmidt Stability.

On the right side, there is a 'Filters' panel with sections for 'From' and 'Until' (both set to 19/11/2024), 'Location', 'Origin' (Measurement (100), Model (13), Satellite (5)), and 'Lake' (a list of 30 lakes with checkboxes).

The screenshot shows the 'LéXPLORE Idronaut Depth Time Grid' visualization. The main plot is a heatmap showing water temperature (color scale from 7.11 to 24.19) over time (x-axis: 25.08, September, 08.09, 15.09, 22.09) and depth (y-axis: 0 to 80 meters). Three white circles are overlaid on the plot with the following text:

- 117 Heterogeneous Datasets
- 60+ Lake Parameters
- 45 Different Lakes

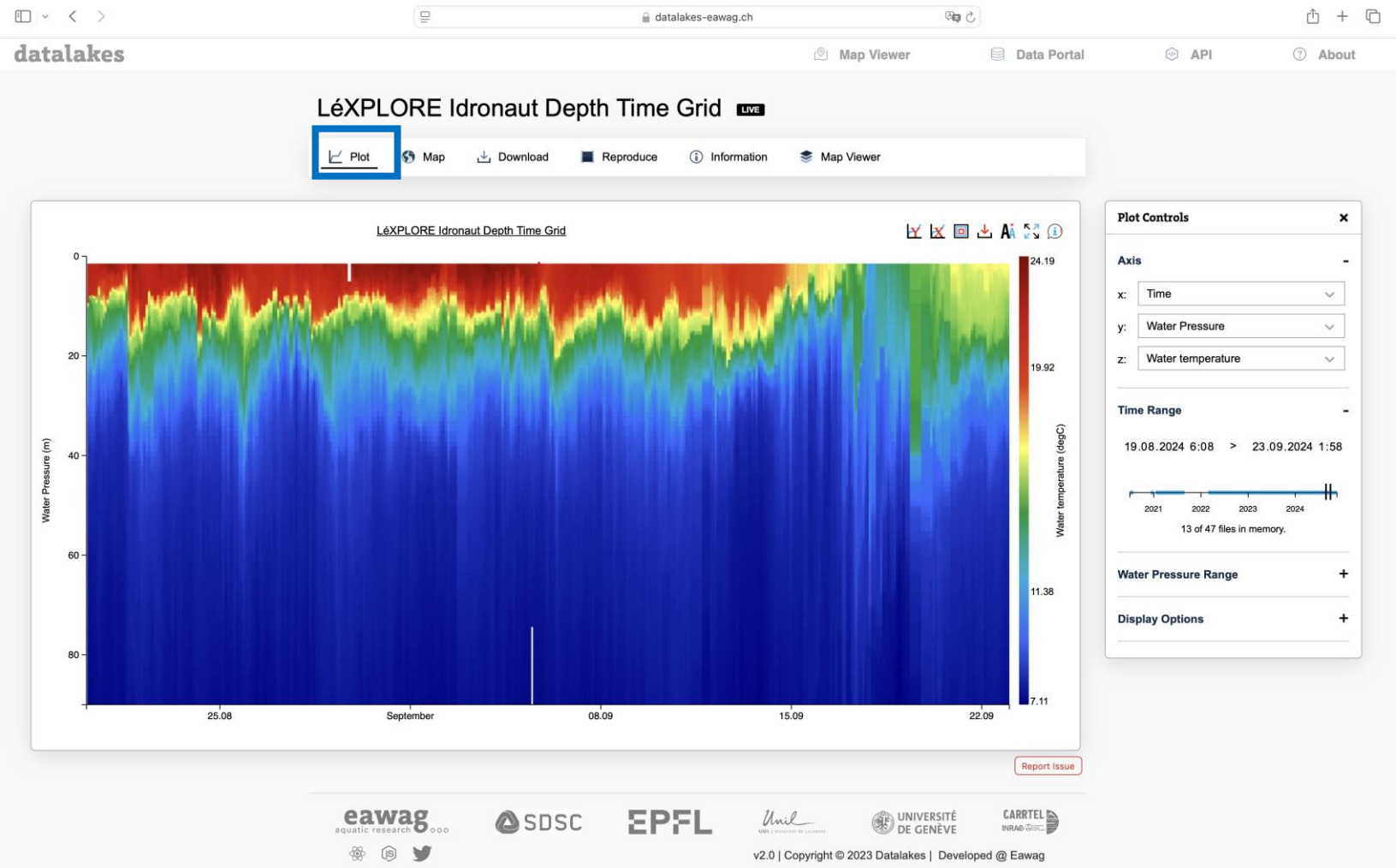
On the right side, there is a 'Plot Controls' panel with the following settings:

- x: Time
- y: Water Pressure
- z: Water temperature
- Time Range: 19.08.2024 6:08 to 23.09.2024 1:58
- Water Pressure Range: +
- Display Options: +

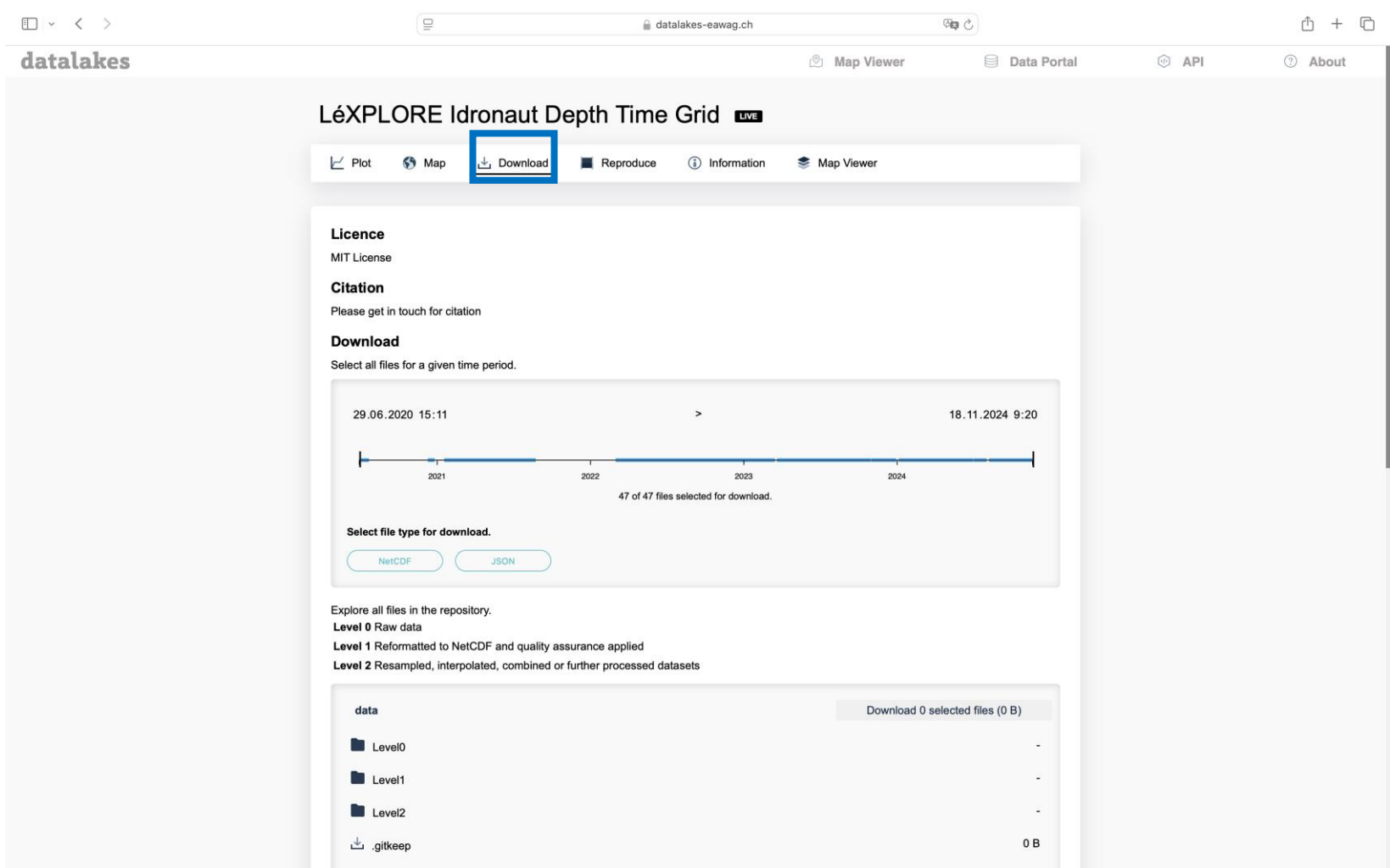
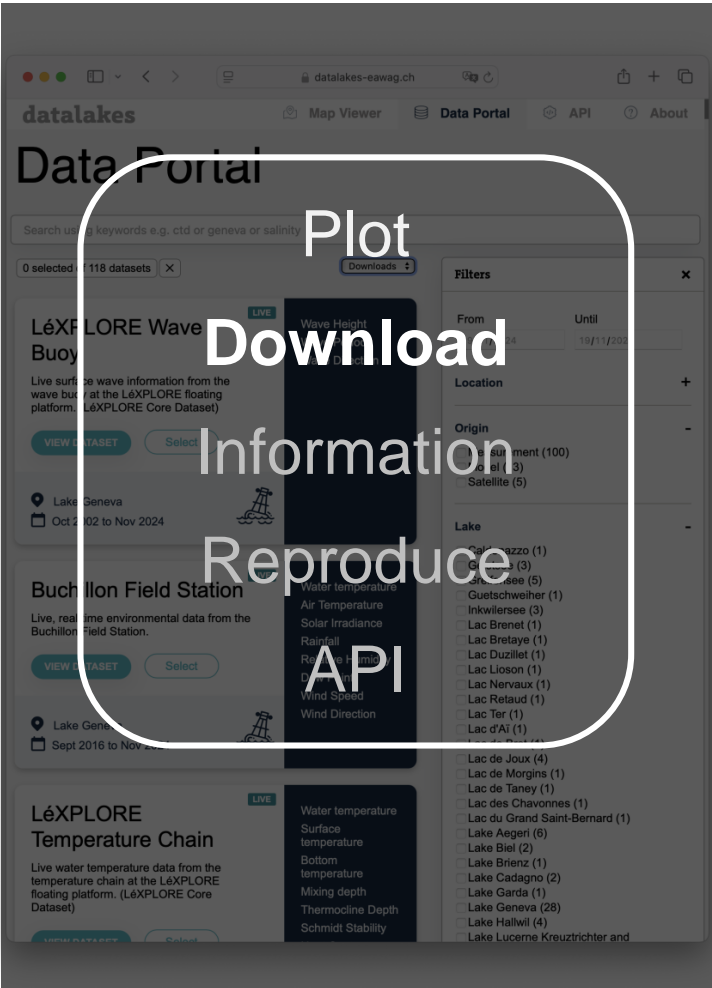
At the bottom of the page, there are logos for eawag, SDSC, EPFL, UNIL, UNIVERSITÉ DE GENÈVE, and CARTEL. The footer text reads: 'v2.0 | Copyright © 2023 Datalakes | Developed @ Eawag'.

PART I In-situ observations DATALAKES at a Glance

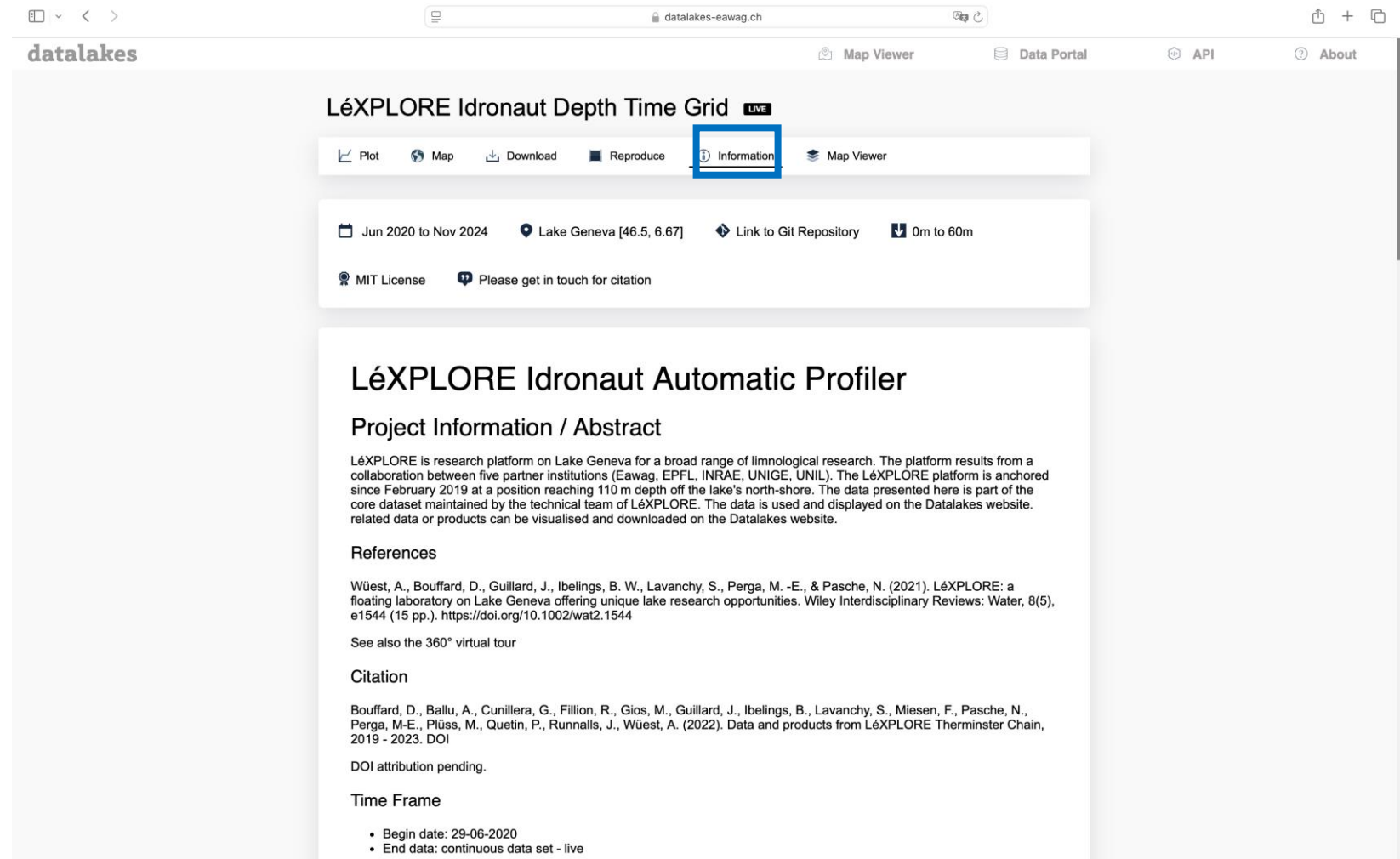
Plot
Download
Information
Reproduce
API



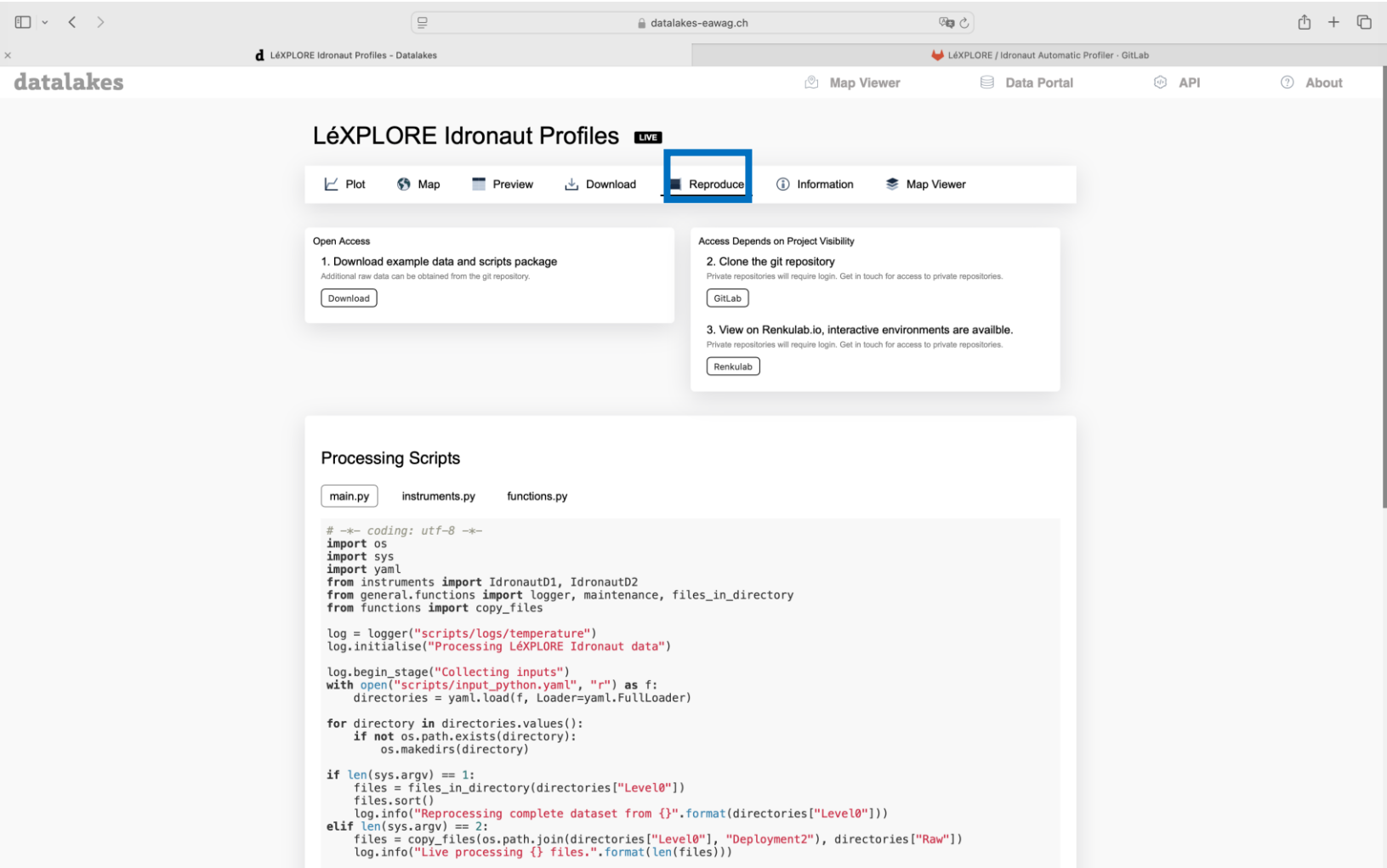
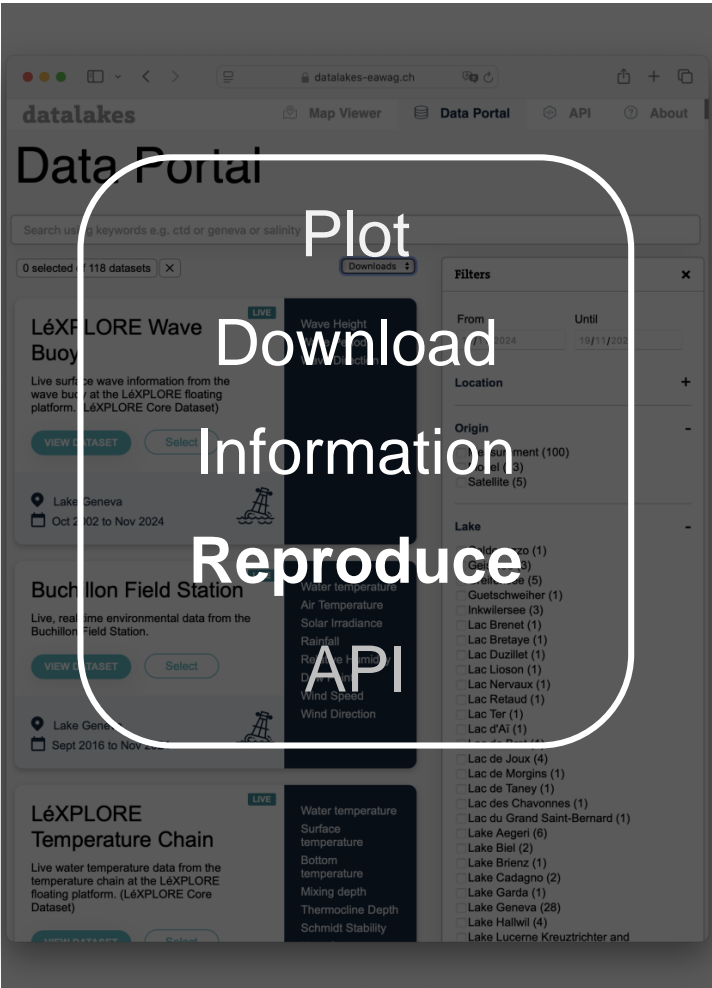
PART I In-situ observations DATALAKES at a Glance



PART I In-situ observations DATALAKES at a Glance

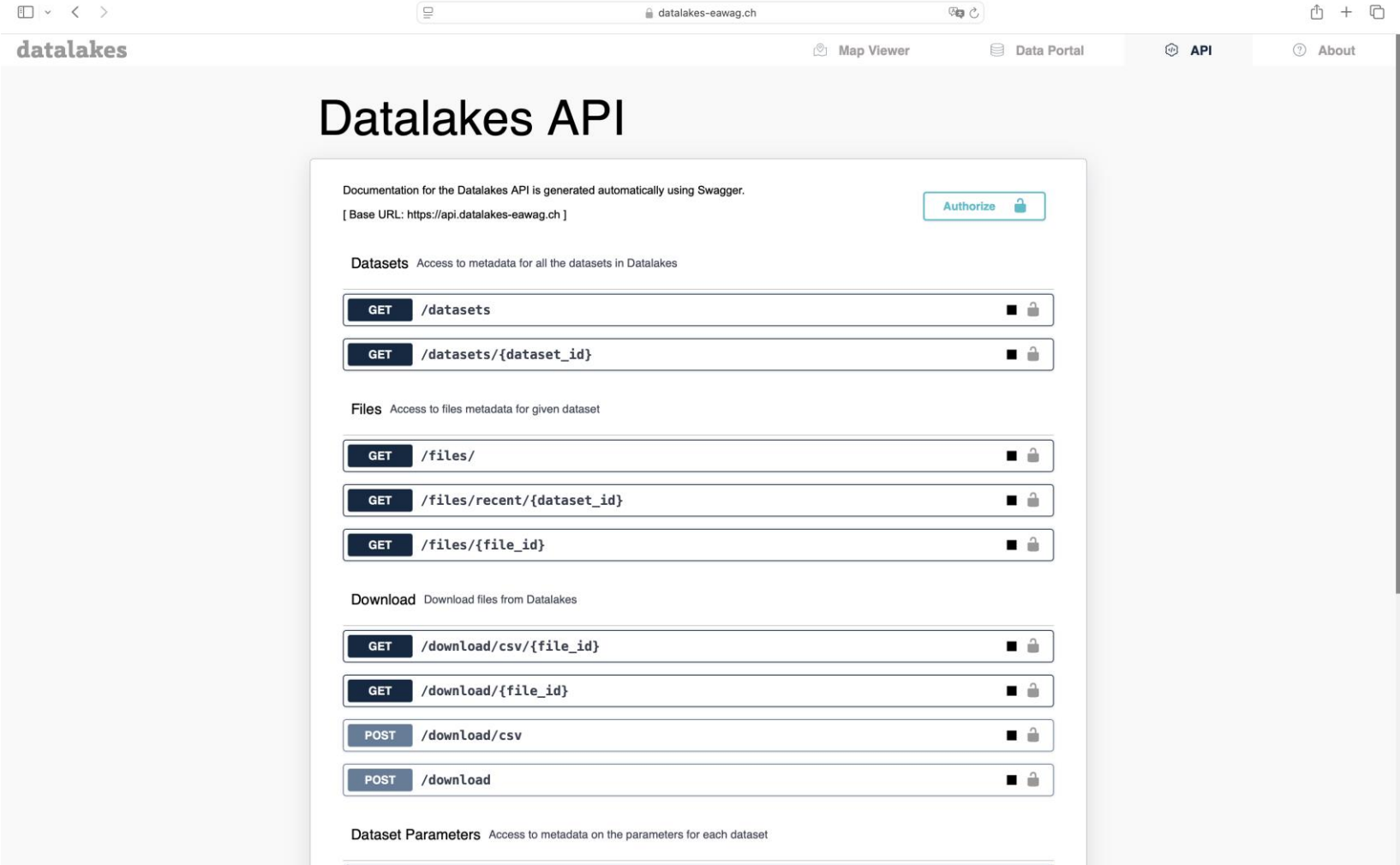
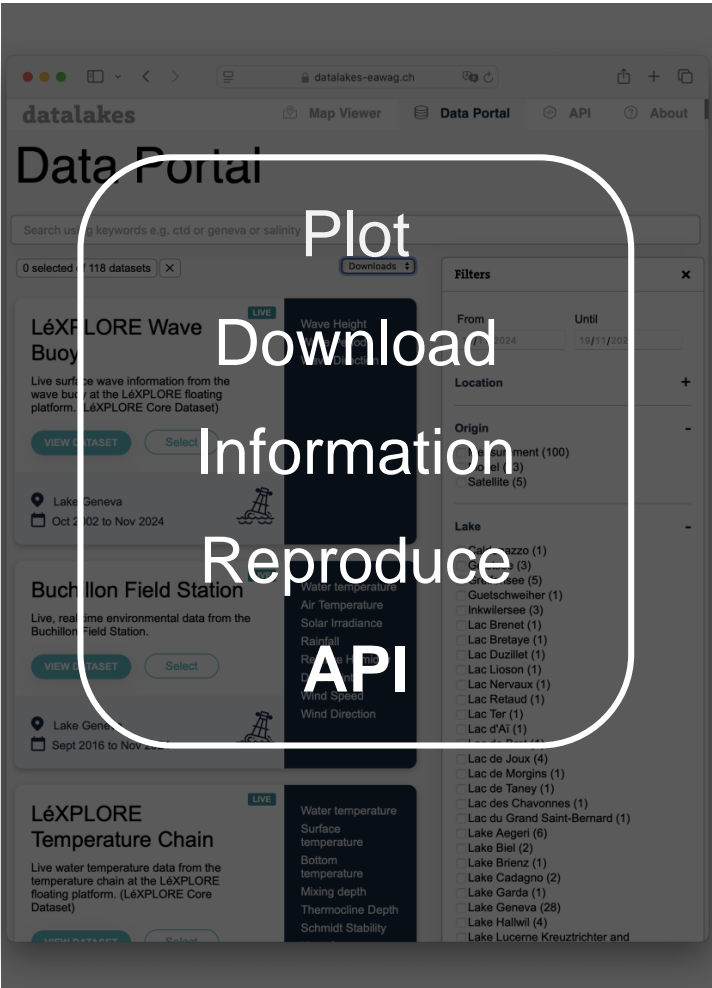


PART I In-situ observations DATALAKES at a Glance



PART I In-situ observations

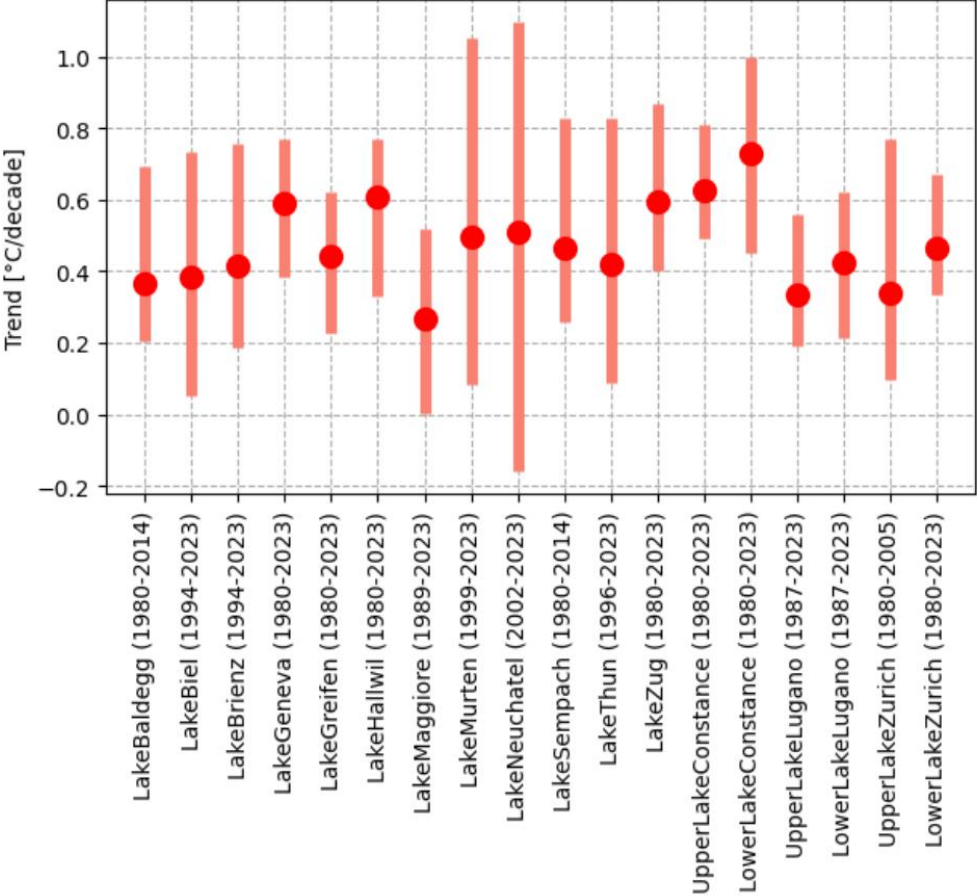
DATALAKES at a Glance



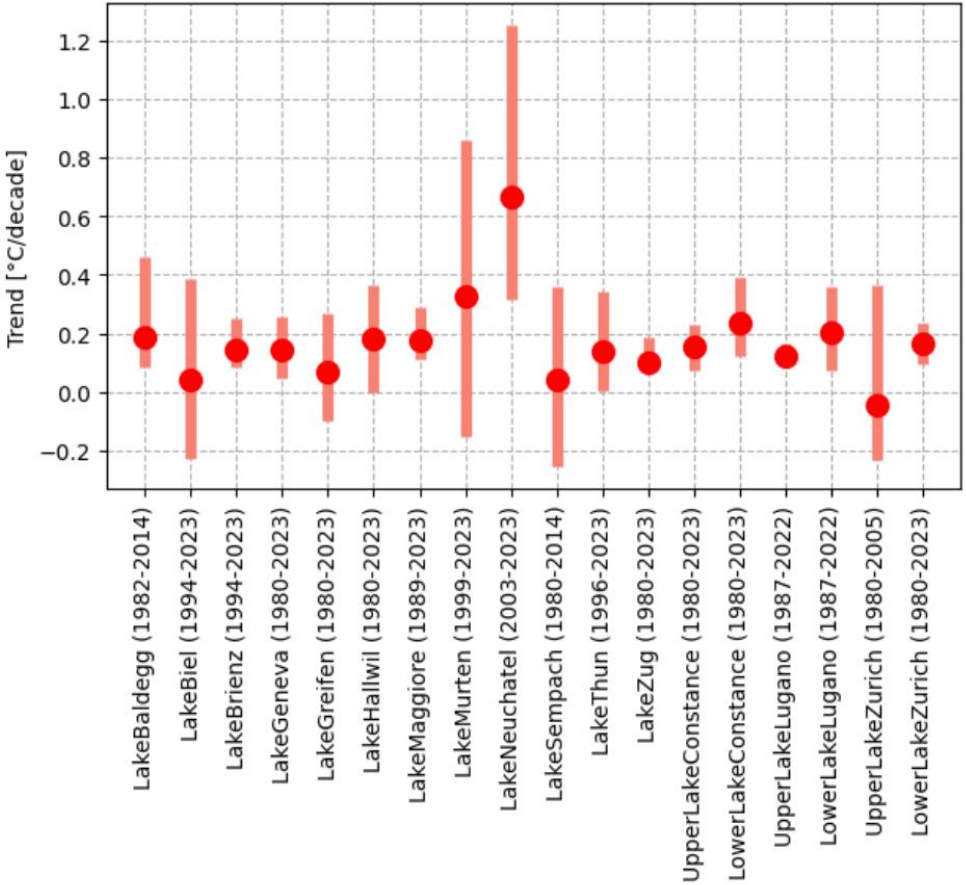
DATALAKES. Science case

Trends & multilakes comparison

Mean annual surface temperatures



Mean annual bottom temperatures



PART II Remote Sensing

Example of initiative: ALPLAKES RS SENCAST

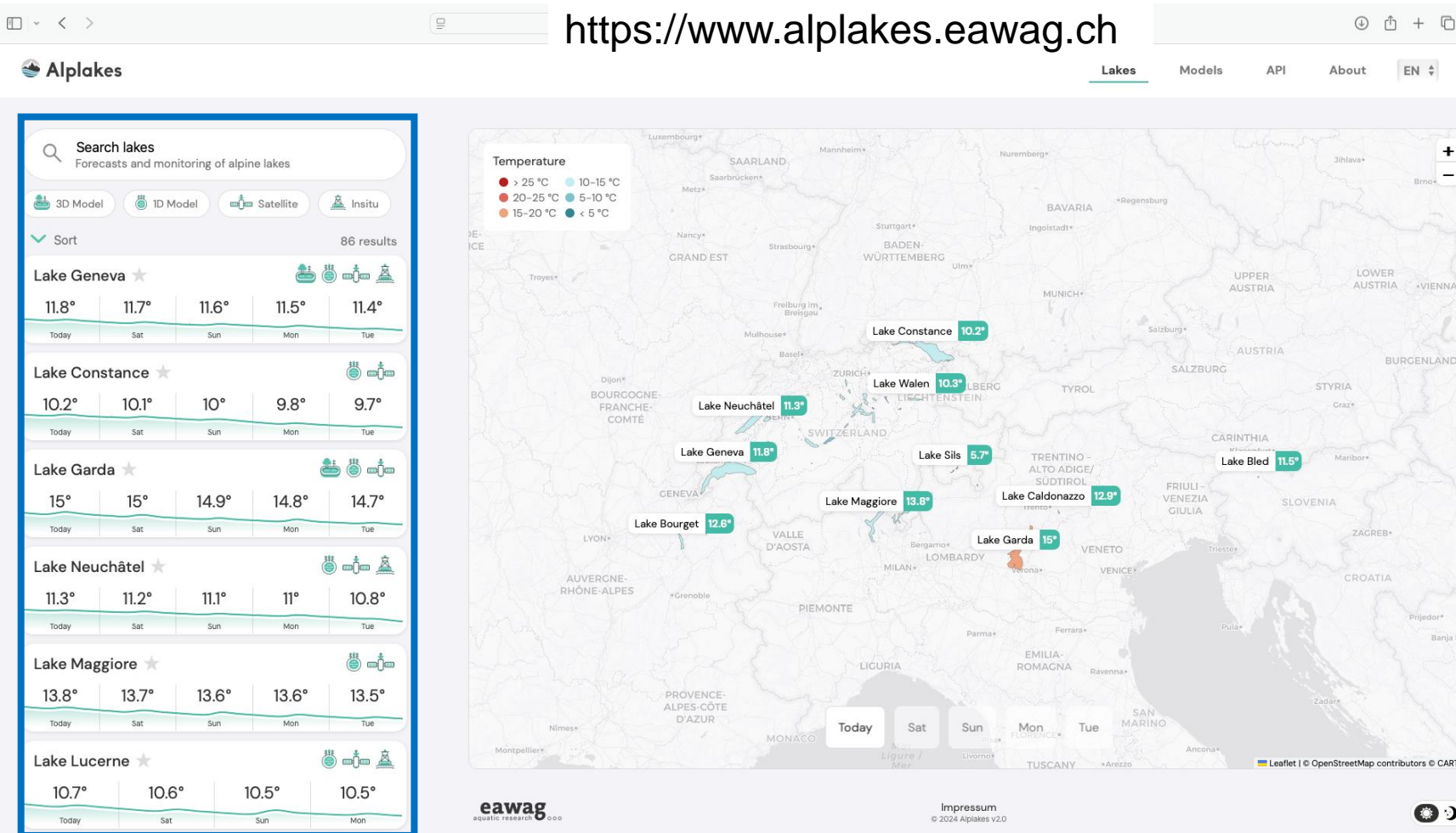
Not discussed here.

See with Daniel Odermatt at the coffee break

or ask questions

PART III Hydrodynamic modelling

Alplakes at a Glance



Motivations:

A web platform for lake models & RS products in the European Alpine region

- 86 Lakes with 1D models
- 12 Lakes with 3D models
- 21 Lakes with RS*

(*) not discussed here. See with **Daniel Odermatt** at the coffee break or ask questions

PART III Hydrodynamic modelling

Alplakes at a Glance

Search lakes
Forecasts and monitoring of alpine lakes

3D Model ID Model Satellite Insitu

Sort 86 results

Lake	Today	Sat	Sun	Mon	Tue
Lake Geneva	11.8°	11.7°	11.6°	11.5°	11.4°
Lake Constance	10.2°	10.1°	10°	9.8°	9.7°
Lake Garda	15°	15°	14.9°	14.8°	14.7°
Lake Neuchâtel	11.3°	11.2°	11.1°	11°	10.8°
Lake Maggiore	13.8°	13.7°	13.6°	13.6°	13.5°
Lake Lucerne	10.7°	10.6°	10.5°	10.5°	

Temperature legend:
● > 25 °C ● 10-15 °C
● 20-25 °C ● 5-10 °C
● 15-20 °C ● < 5 °C

Map labels:
Lake Bourget: 12.6°
Lake Geneva: 11.8°
Lake Neuchâtel: 11.3°
Lake Constance: 10.2°
Lake Walen: 10.3°
Lake Sils: 5.7°
Lake Maggiore: 13.8°
Lake Caldonazzo: 12.9°
Lake Garda: 15°
Lake Bled: 11.5°

Navigation: Today Sat Sun Mon Tue

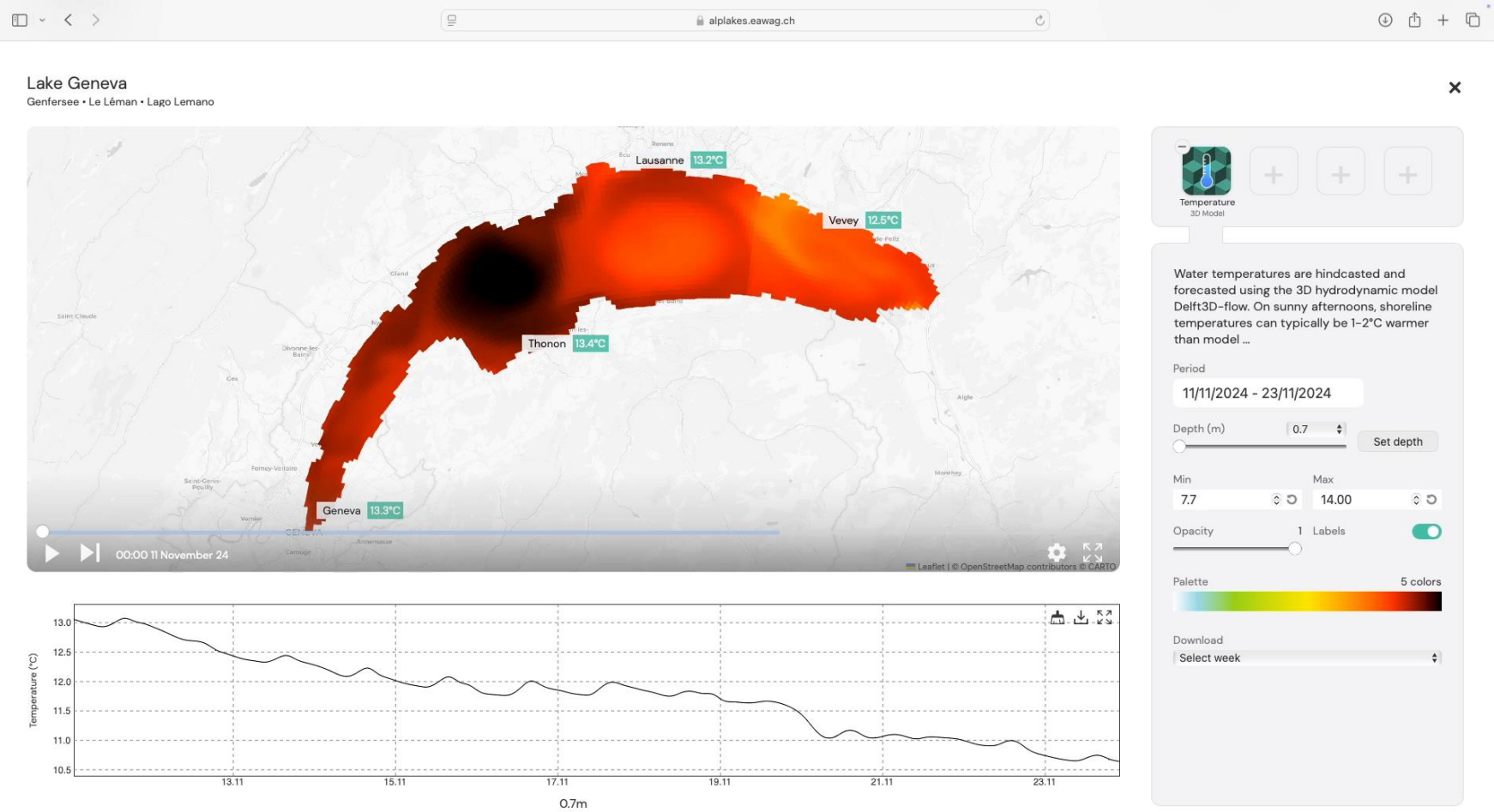
eawag aquatic research
Impressum © 2024 Alplakes v2.0

A web platform for lake models & RS products in the European Alpine region

- Operational models
- 5 day forecast

PART III Hydrodynamic modelling

Alplakes 3D at a Glance



Example of Lake Geneva

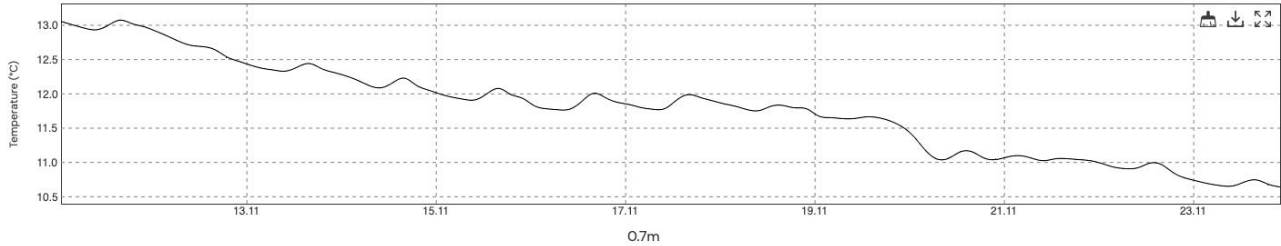
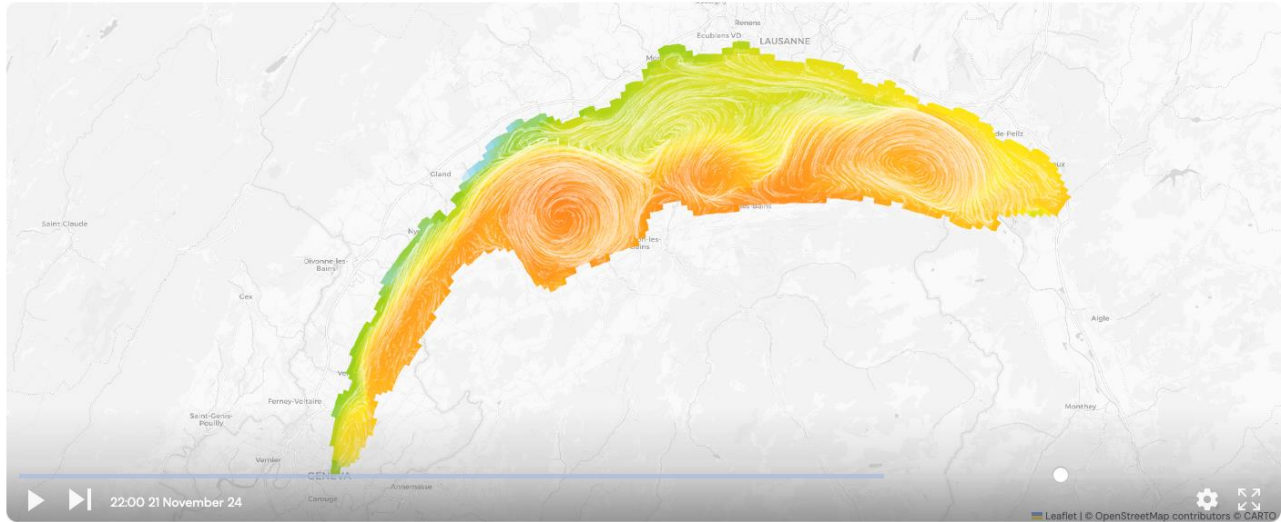
- Operational models
- 5 day forecast
- Lake Temperature

PART III Hydrodynamic modelling

Alplakes 3D at a Glance

<https://www.alplakes.eawag.ch>

Lake Geneva
Genfersee • Le Léman • Lago Lemano



Current 3D Model Temperature 3D Model

Water temperatures are hindcasted and forecasted using the 3D hydrodynamic model Delft3D-flow. On sunny afternoons, shoreline temperatures can typically be 1-2°C warmer than model ...

Period
11/11/2024 - 24/11/2024

Depth (m) 0.7 Set depth

Min 7.72 Max 14.09

Opacity 1 Labels

Palette 5 colors

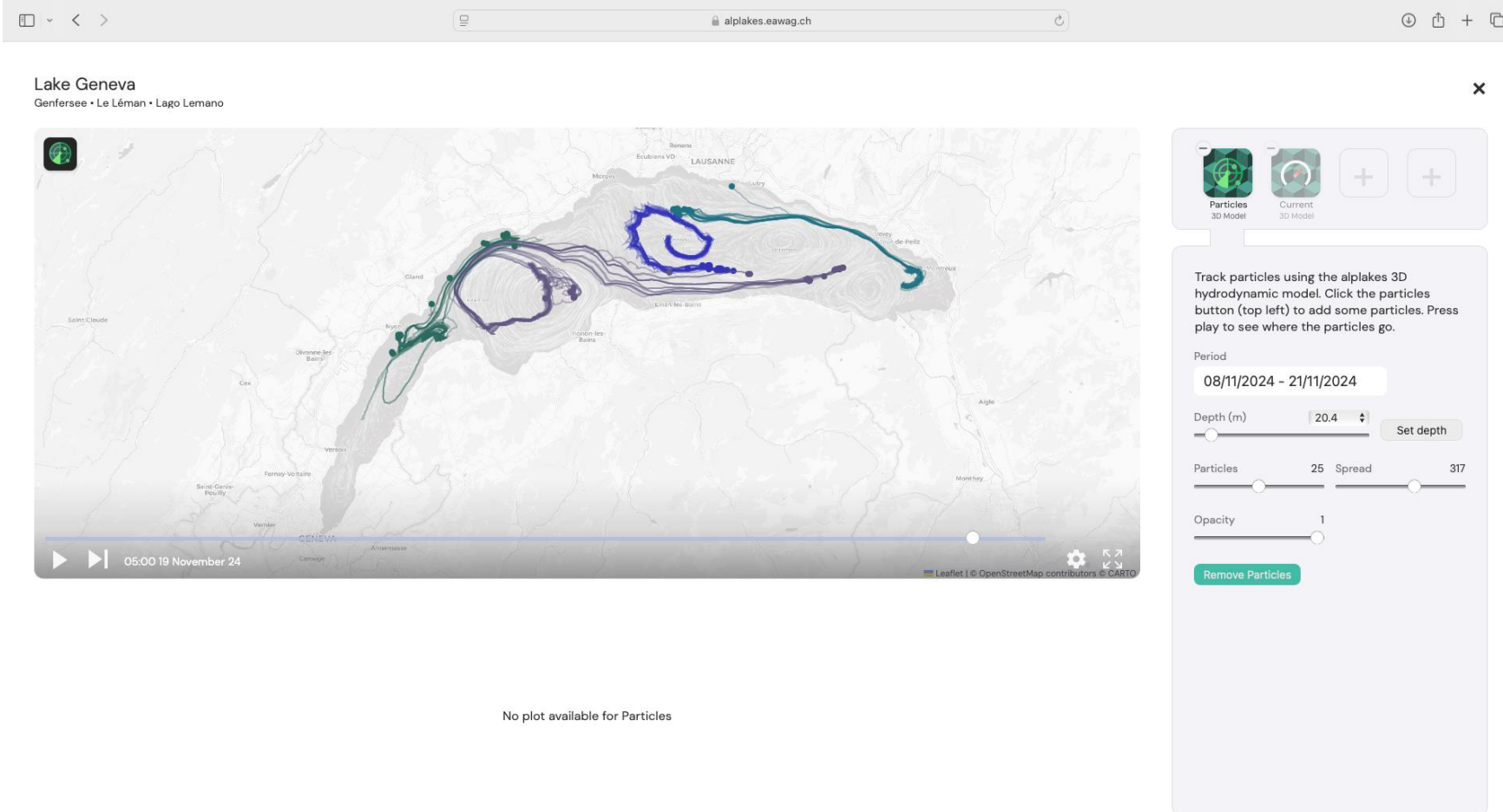
Download Select week

Example of Lake Geneva

- Operational models
- 5 day forecast
- Lake Temperature
- Lake Circulation

PART III Hydrodynamic modelling

Alplakes 3D at a Glance



Going beyond 3D models
with products

Particle tracking

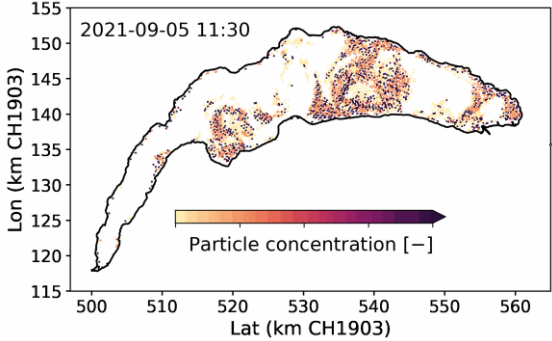
- Online particle tracking
- Offline particle tracking

PART III Hydrodynamic modelling. Science case

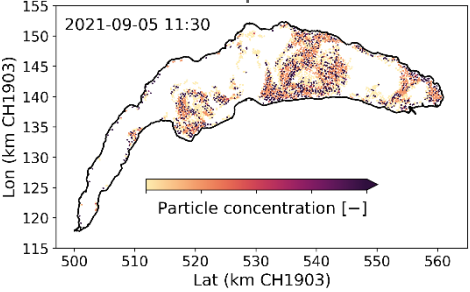
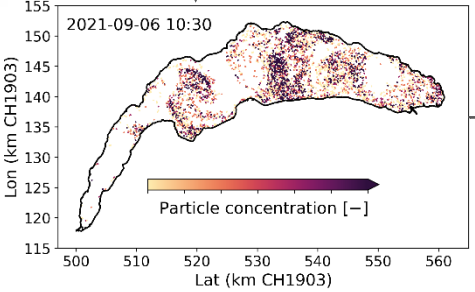
Analysis of observed patterns

3D hydrodynamic modeling coupled with PT module

PT spatiotemporal map

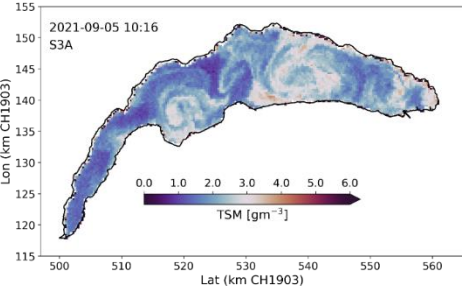


*PT results:
PT map Day_1*

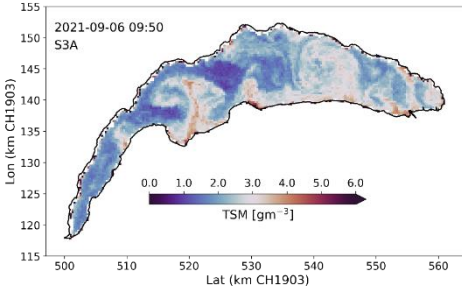


*PT seed generator:
PT map Day_0*

*Satellite products:
TSM map Day_0*



*Satellite products:
TSM map Day_1*

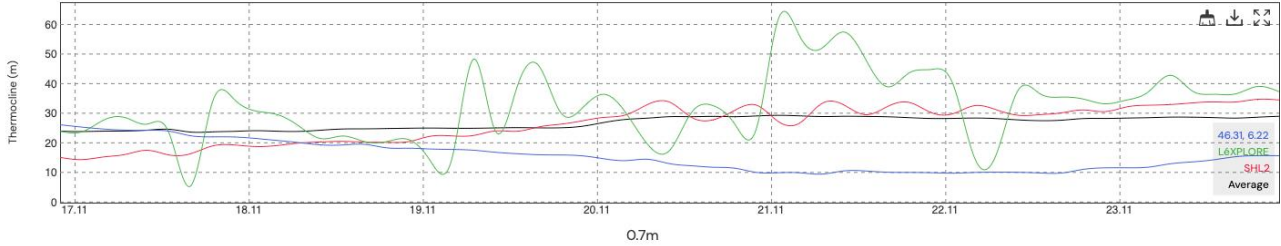
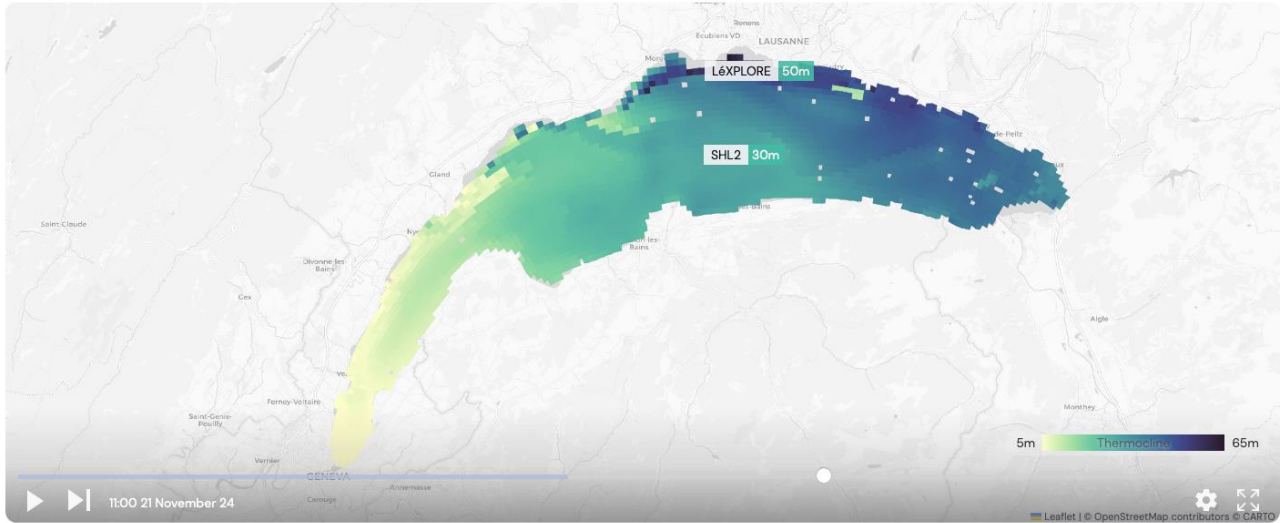


PART II Hydrodynamic modelling

Alplakes 3D at a Glance

<https://www.alplakes.eawag.ch>

Lake Geneva
Genfersee • Le Léman • Lago Lemano



Thermocline 3D Model

Thermocline depth calculated using Pylake and the 3D hydrodynamic model Delft3D-flow. Meteorological forcing data is produced from Meteowiss products, hincasts use the Cosmo-1e 1...

Period: 16/11/2024 - 23/11/2024

Depth (m): 0.7

Min: 5, Max: 65

Opacity: 1, Labels:

Palette:

Download: Select week

Going beyond 3D models with products

Particle tracking

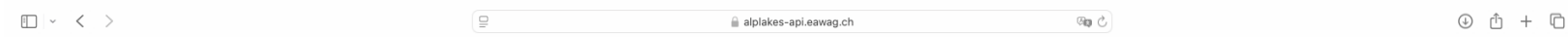
- Online particle tracking
- Offline particle tracking

Thermocline depth

Etc etc

PART III Hydrodynamic modelling

Alplakes 3D at a Glance



Alplakes API 2.0.0 OAS3

/openapi.json

Alplakes API connects you to lake products produced by the [SURE](#) department at [EAWAG](#).

This includes terabytes of simulation data and remote sensing products. The API supports geospatial and temporal queries, allowing access to subsets of the data for easier handling.

This API serves as the backend for the website www.alplakes.eawag.ch.

Disclaimer

The **Alplakes API** is provided "as is," without any guarantees regarding the accuracy, completeness, or timeliness of the data. While we strive to ensure data quality, users are responsible for verifying information before making any decisions based on it.

Additionally, we cannot guarantee continuous availability of the API. Service disruptions or maintenance periods may occur, and users should expect intermittent downtime.

Get in Touch

For bug reports, collaboration requests, or to join our mailing list for updates, feel free to [get in touch](#).

Contact [James Runnalls](#)

[Apache 2.0](#)

3D Simulations ^

GET	/simulations/metadata	Simulations Metadata	▼
GET	/simulations/metadata/{model}/{lake}	Simulations Metadata Lake	▼
GET	/simulations/file/{model}/{lake}/{sunday}	Simulations File	▼
GET	/simulations/point/{model}/{lake}/{start_time}/{end_time}/{depth}/{lat}/{lng}	Simulations Point	▼
GET	/simulations/layer/{model}/{lake}/{time}/{depth}	Simulations Layer	▼
GET	/simulations/layer/average_temperature/{model}/{lake}/{start_time}/{end_time}/{depth}	Simulations Layer Average Temperature	▼
GET	/simulations/profile/{model}/{lake}/{time}/{lat}/{lng}	Simulations Profile	▼
GET	/simulations/depthtime/{model}/{lake}/{start_time}/{end_time}/{lat}/{lng}	Simulations Depth Time	▼
GET	/simulations/transect/{model}/{lake}/{time}/{lats}/{lngs}	Simulations Transect	▼

Model output download

- API system

PART III Hydrodynamic modelling

Alplakes 3D at a Glance

alplakes-simulations / notebooks / process_results.ipynb

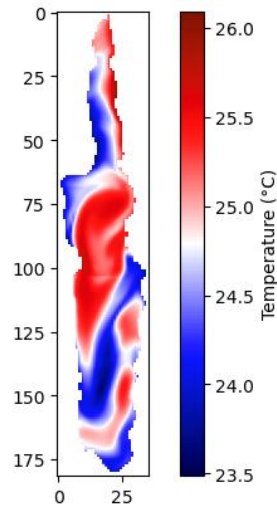
Preview Code Blame 378 lines (378 loc) · 84.8 KB

Temperature

The plots are distorted by the lack of inclusion of global coordinates, these can be accessed in the XZ and YZ variables.

```
In [7]: temperature = np.array(nc.variables["R1"][time_index, 0, depth_index, :])
temperature[temperature == -999] = np.nan
plt.imshow(temperature, cmap='seismic')
plt.colorbar(label="Temperature (°C)")
```

Out [7]: <matplotlib.colorbar.Colorbar at 0x71aa79764c70>



Model output download

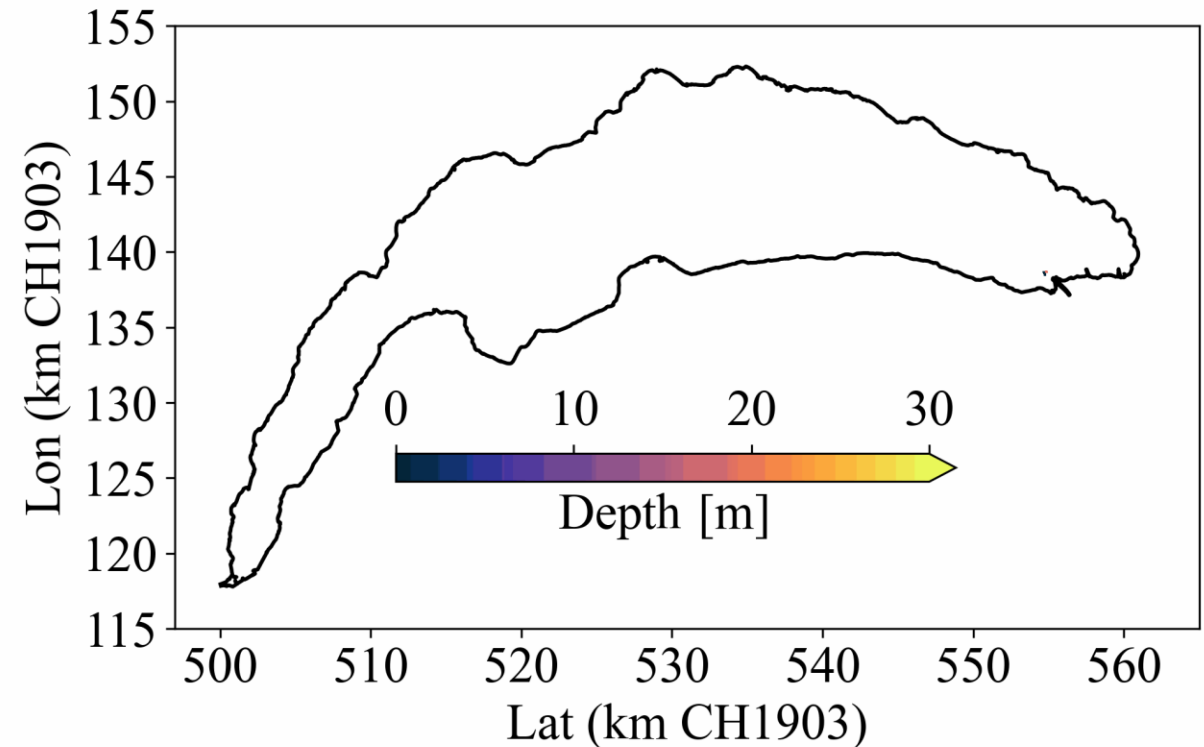
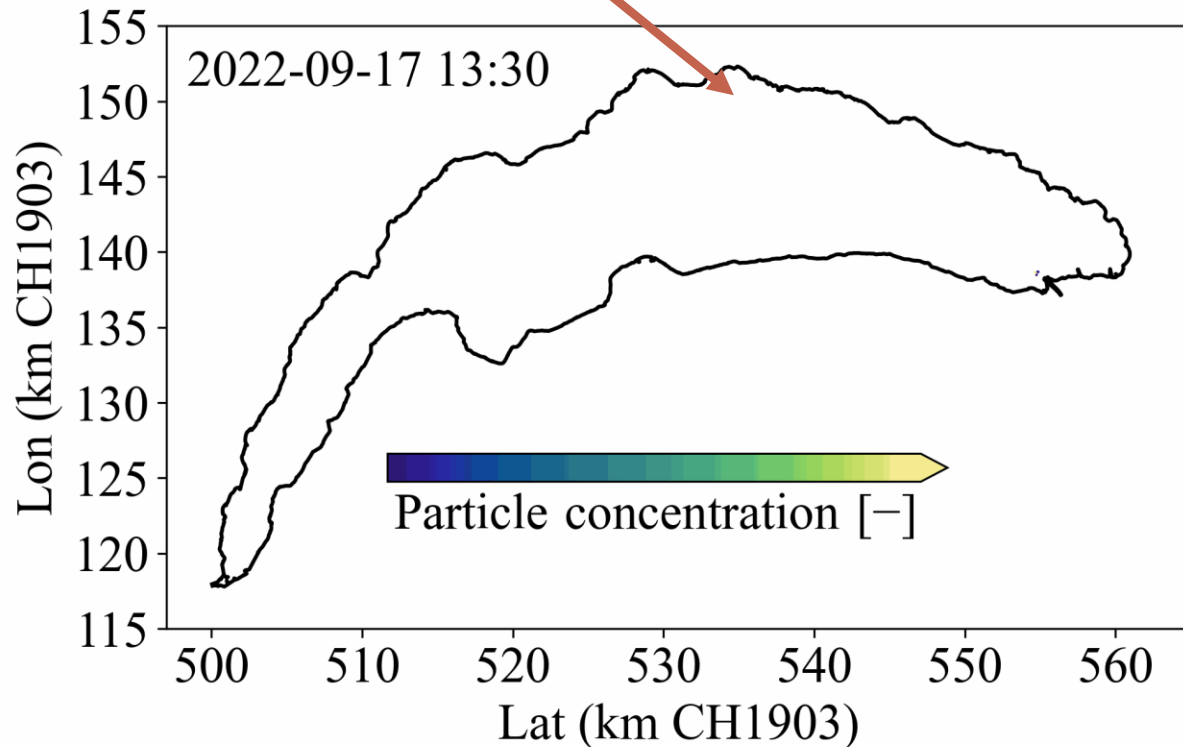
- API system
- Documented Jupyter Notebook for using model output

PART III Hydrodynamic modelling. Science case

Role of lateral transport in biogeochemical budgets

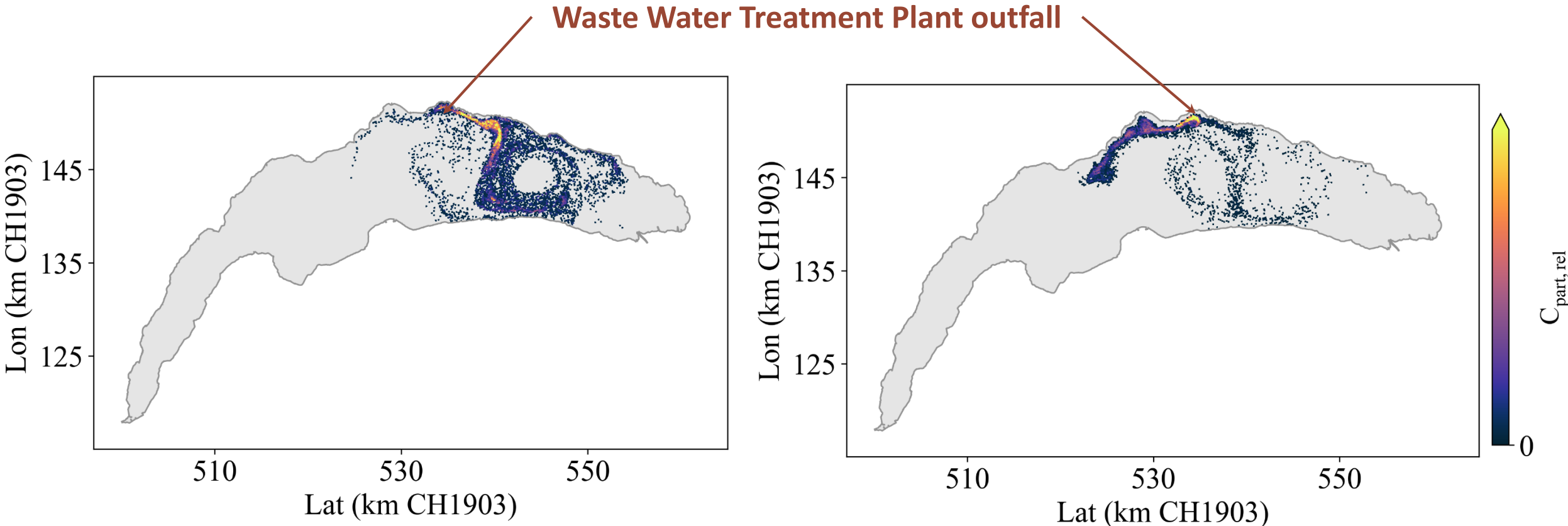


Where do the measured CH_4 on LéXPLORE mainly originate from?



PART III Hydrodynamic modelling. Science case

Tracking the fate of bacteria released from WWTP

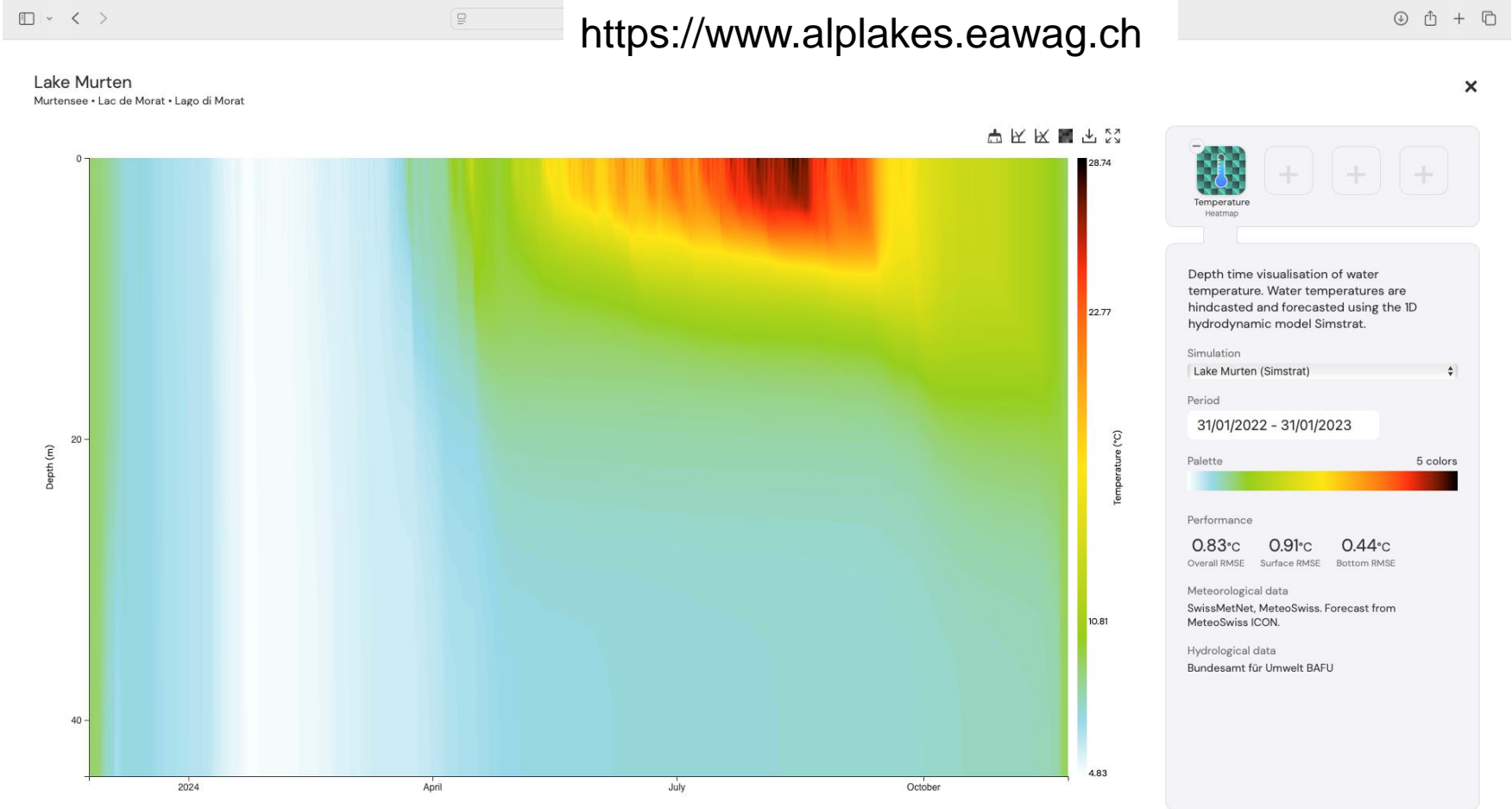


Want to know how to use 3D models & particle tracking to follow in the field the same parcel of water?
See Anne Leroquais' poster

Credit Abolfazl Irani Rahaghi. Project Helmut Bürgmann

PART III Hydrodynamic modelling

Alplakes 1D at a Glance

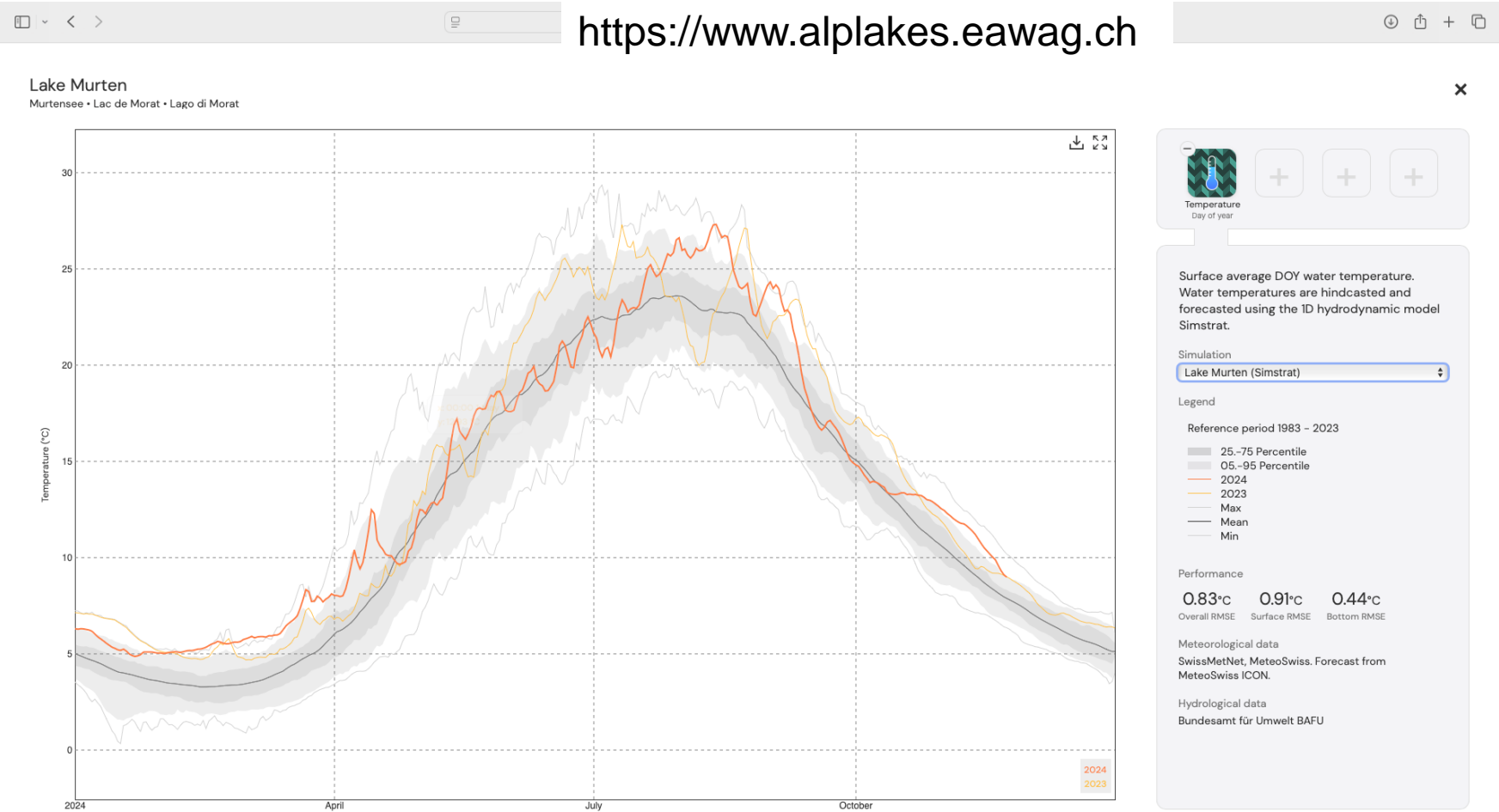


1D simulations

- Temperature: Simstrat model

PART III Hydrodynamic modelling

Alplakes 1D at a Glance



1D simulations

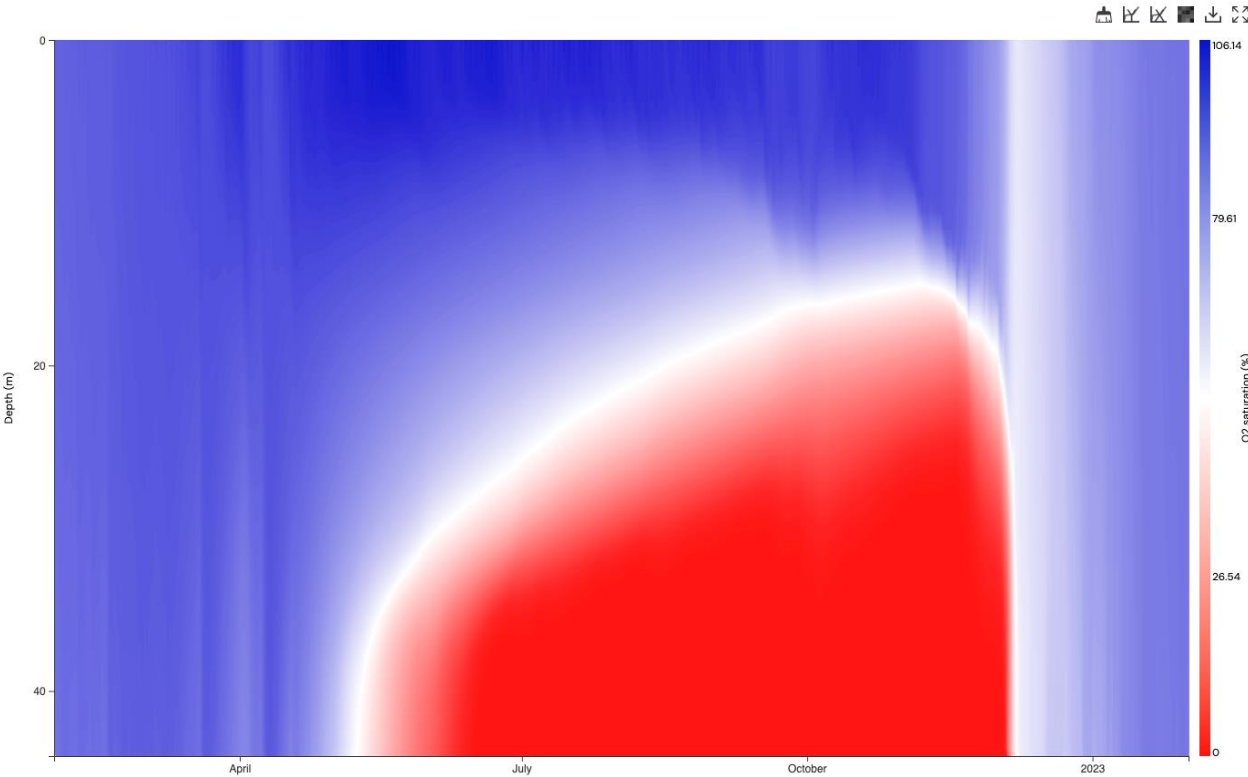
- Temperature: Simstrat model
- Multi year comparisons

PART III Hydrodynamic modelling

Alplakes 1D at a Glance

<https://www.alplakes.eawag.ch>

Lake Murten
Murtensee • Lac de Morat • Lago di Morat



O₂ saturation Heatmap

Depth time visualisation of oxygen saturation. Oxygen values are hindcasted and forecasted using the 1D hydrodynamic model Simstrat in combination with AED2. The oxygen model is a ...

Simulation
Lake Murten (Simstrat)

Period
31/01/2022 - 31/01/2023

Palette
gradient red white blue

Performance
0.83% Overall RMSE 0.91% Surface RMSE 0.44% Bottom RMSE

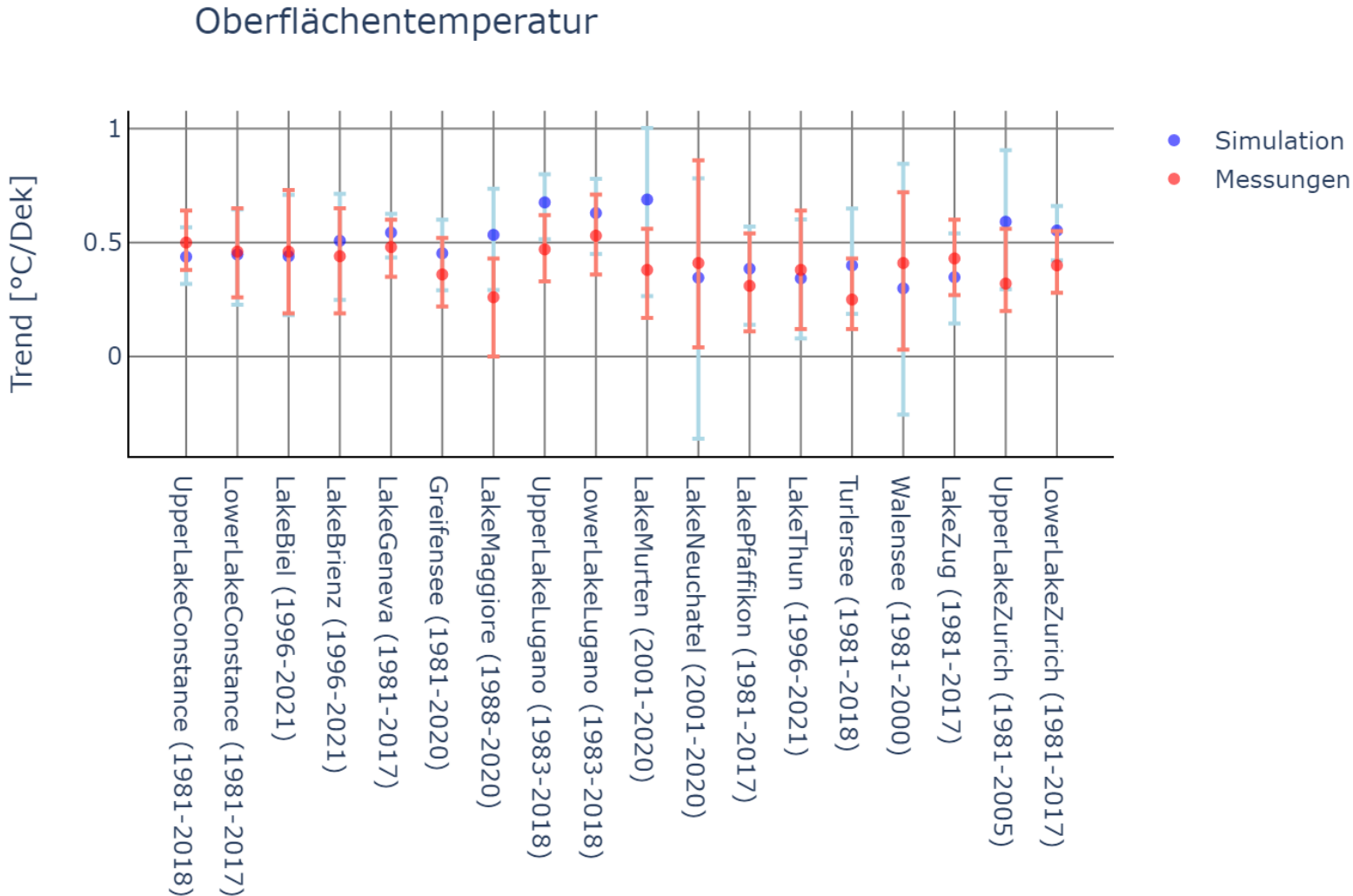
Meteorological data
SwissMetNet, MeteoSwiss. Forecast from MeteoSwiss ICON.

Hydrological data
Bundesamt für Umwelt BAFU

1D simulations

- Temperature: Simstrat model
- Multi year comparisons
- Oxygen: Simstrat AED model

PART III Hydrodynamic modelling. Science case



Use case

- Lake trend comparison
- Detect interesting lakes (outliers)

Conclusion

<https://www.alplakes.eawag.ch>

Aplakes an online open tool to promote the use of RS, hydrodynamic and water quality models

Aplakes can host all kind of models

Aplakes was designed to be "easily" (thanks James) upscaled



ALPLAKES

The Team



For 2024:

Marina Amadori, Fabien Bärenbold, Damien Bouffard, Mariano Bresciani, Claudia Giardino, Abolfazl Irani Rahaghi, Anne Leroquais, **James Runnalls**, Martin Schmid, Daniel Odermatt, Marco Toffolon, Mortimer Werther

For 2025:

YOU?

Fundings:

ESA, Eawag

<https://www.alplakes.eawag.ch>

Conferences 2025



EGU2025 27 April - 2 May 2025 <https://www.egu25.eu/>

HS10.4 [Lakes and inland seas in the changing environment](#)

HS10.5 [Towards an integrated lake-catchment perspective](#)

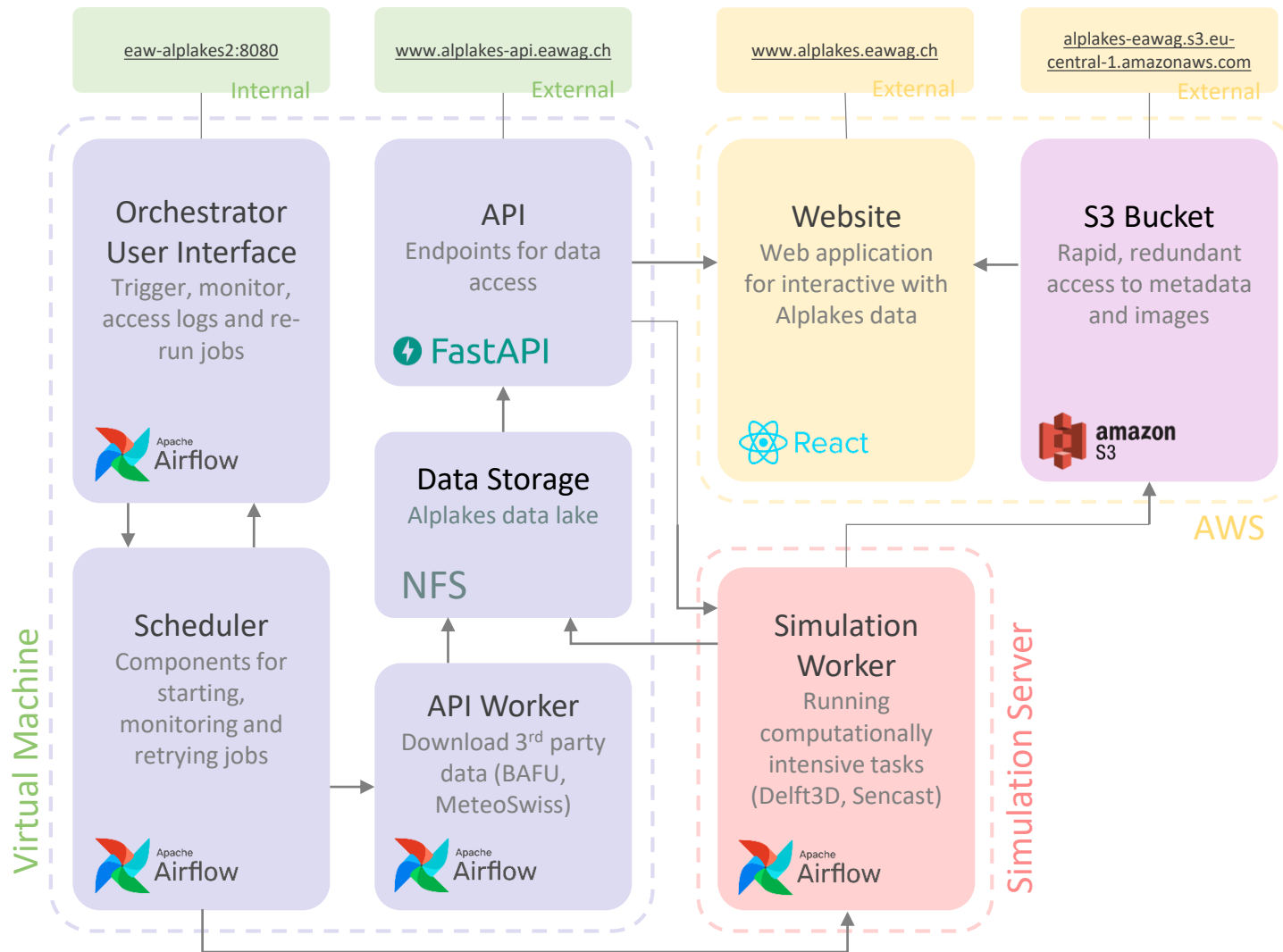
HS10.8 [Opportunities and risks in upscaling limnological research from local to global](#)

Physical Processes in Natural Waters 2025



Kingston, Ontario 7 July – 11 July 2025

<https://ppnw2025.smithengineering.queensu.ca>

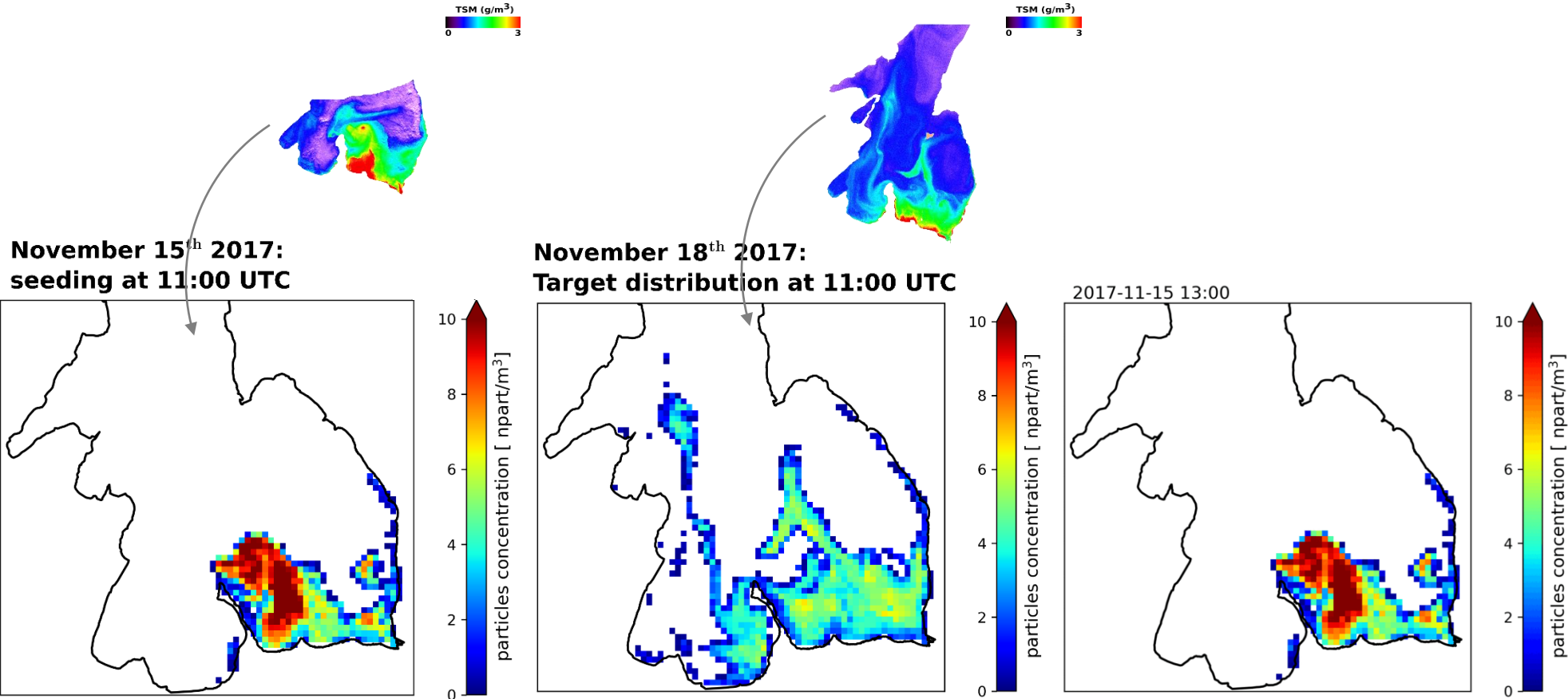


Result

Micro-services split between an Eawag hosted VM and a simulation server purchased specifically for this project.

PART III Hydrodynamic modelling

Science application.



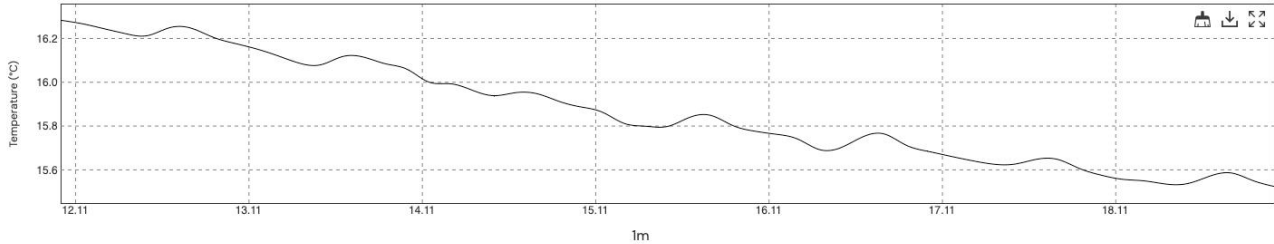
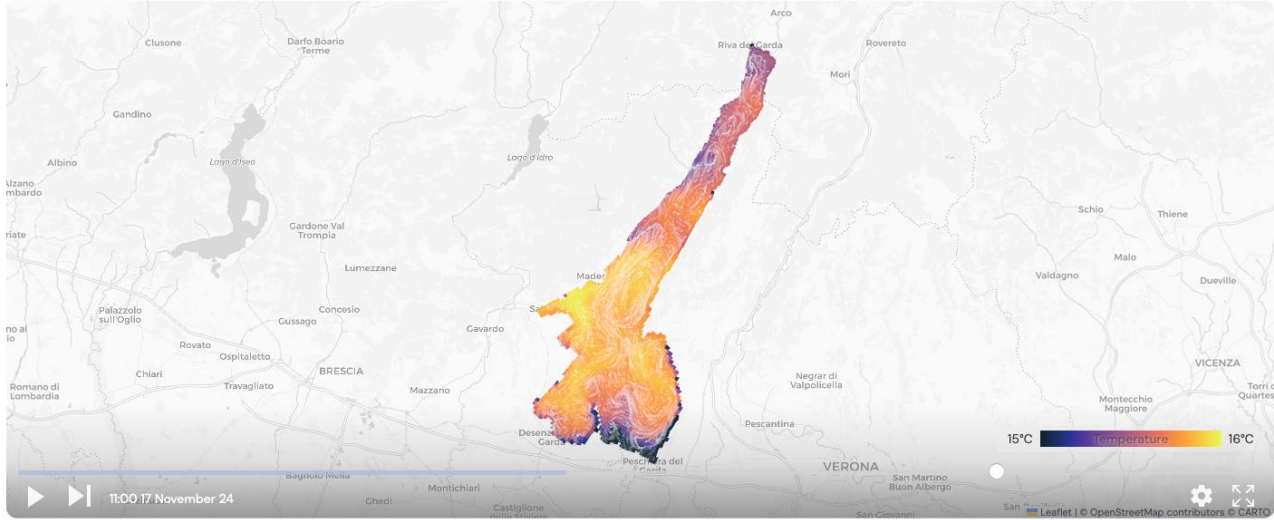
Amadori et al., In preparation

PART III Hydrodynamic modelling

Alplakes 3D at a Glance

<https://www.alplakes.eawag.ch>

Lake Garda
Gardasee • Lac de Garde • Lago di Garda



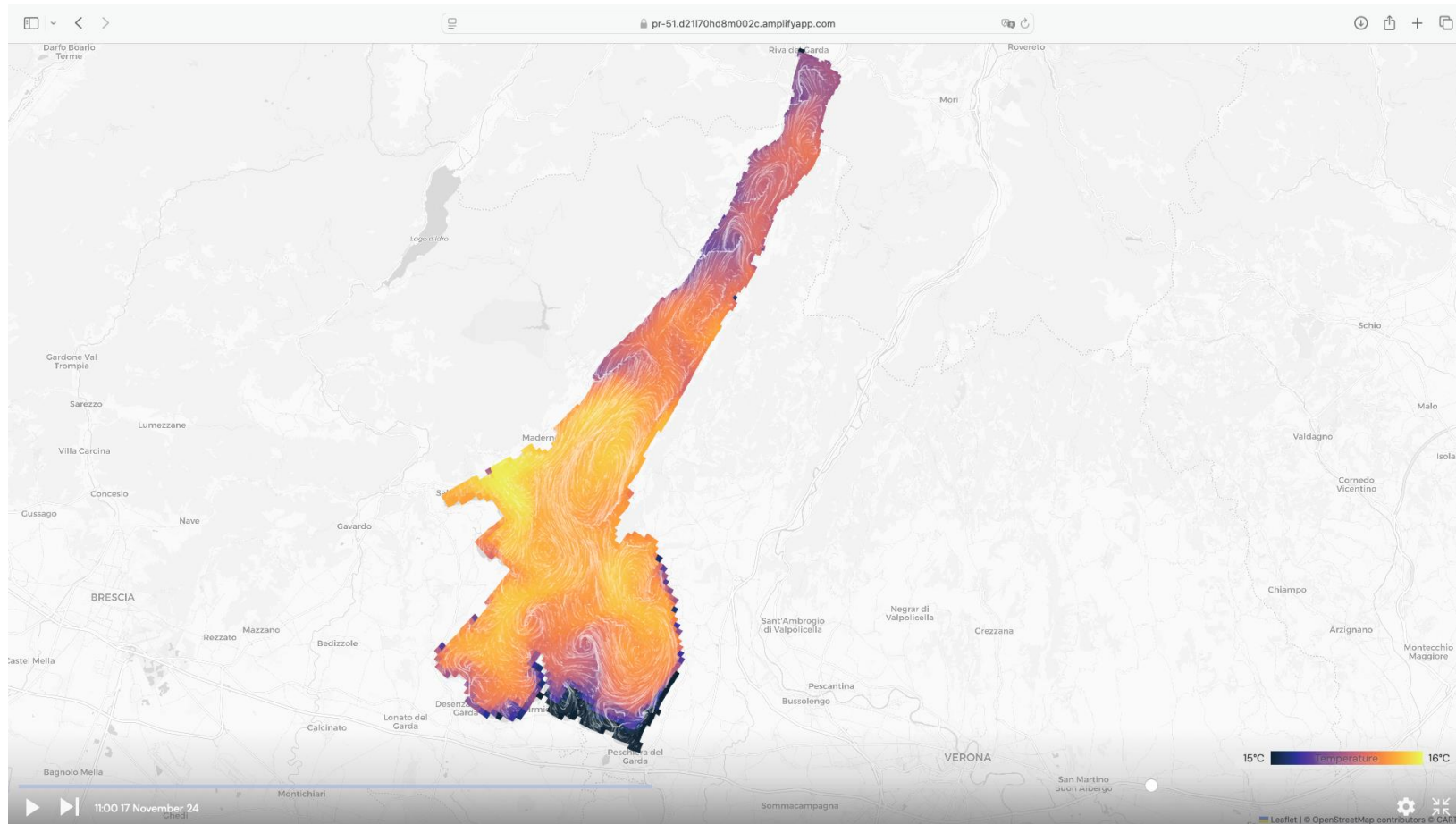
A screenshot of the Alplakes 3D model interface. The interface includes a toolbar with icons for 'Current 3D Model' and 'Temperature 3D Model'. Below the toolbar, there is a text box stating: "Water temperatures are hindcasted and forecasted using the 3D hydrodynamic model Delft3D-flow. On sunny afternoons, shoreline temperatures can typically be 1-2°C warmer than model ...". The interface also features a 'Period' selector set to "11/11/2024 - 18/11/2024", a 'Depth (m)' selector set to "1", and a 'Set depth' button. There are also 'Min' and 'Max' temperature selectors set to "9.12" and "16.7" respectively, an 'Opacity' slider set to "1", and a 'Labels' toggle. A 'Palette' selector is set to "Thermal", and a 'Download' dropdown menu is set to "Select week".

Example of Lake Garda

- Operational models
- 5 day forecast
- Lake Temperature
- Lake Circulation

PART III Hydrodynamic modelling

Alplakes 3D at a Glance



Example of Lake Garda

- Operational models
- 5 day forecast
- Lake Temperature
- Lake Circulation