Two very different summers for Lake Geneva as observed by the LéXPLORE platform

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INTRODUCTION

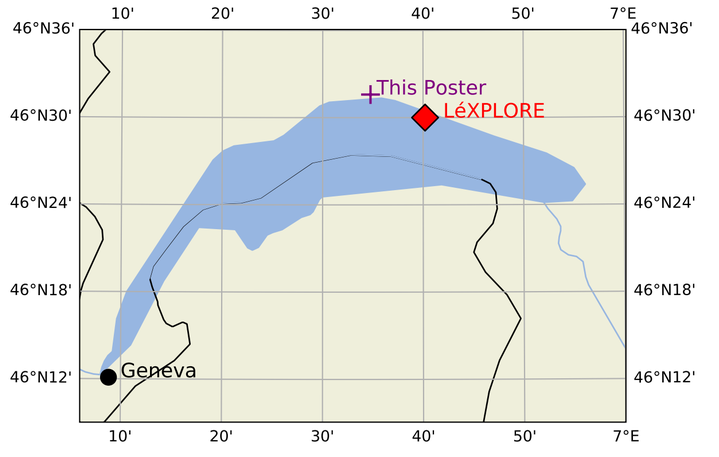
LéXPLORE is a **10 m by 10 m pontoon equipped with high-tech instrumentation** and installed on Lake Leman for 8 years. This novel infrastructure will provides continuous measurements, days and nights for all weather conditions.

Environmental sciences depend heavily on observational data. Successful studies of ecological processes in lakes require in-situ data that cover the relevant temporal scales from milliseconds to entire seasons. Temporal and spatial coverage requirements represent a non-trivial challenge in lake sciences, which have traditionally used sampling campaigns conducted from research vessels or anchored moorings.

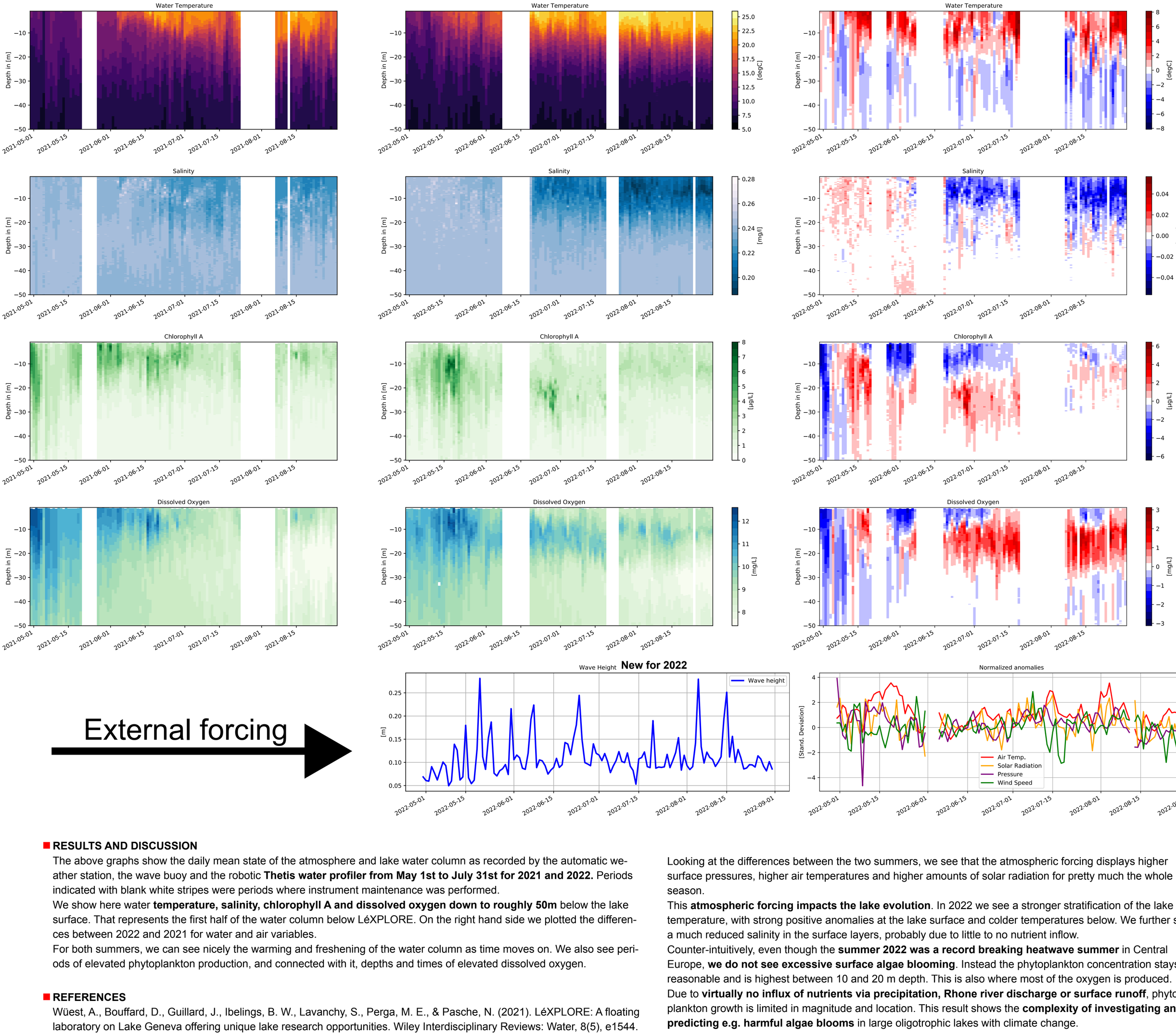
A **consortium of five partner institutions constructed an open-water, multipurpose platform on Lake Geneva** (Switzerland/France) for a broad range of limnological research. The LéXPLORE platform, anchored since February 2019 at a position **reaching 110 m depth off the lake's north-shore**, provides workspace for a large number of instruments and staff working in parallel on individual or integrated multidisciplinary projects. The safe, dry and protected floating laboratory offers direct access to the lake environment for high-sensitivity, high-throughput analyses (Wüest et al., 2021).

LOCATION

Site location specifications were (a) a distance far enough offshore to ensure **open water conditions**, (b) positioning above depths that represent a substantial part of the hypolimnetic water column, and (c) a location that addressed concerns of other lake stakeholders. The **final location was negotiated** with the granting governmental authorities, professional fishermen, water police, public transport etc.
The platform has (a) **stability and ability to withstand a 100-year storm**, (b) heavy structure to minimize motion, (c) spatial layout allowing adequate equipment installation,(d) a sheltered laboratory for working with non-weatherproof equipment, (e) space for moonpools that access the lake both inside and outside the cabin (Wüest et al., 2021).



2021 2022 Diff.



External forcing

RESULTS AND DISCUSSION

The above graphs show the daily mean state of the atmosphere and lake water column as recorded by the automatic weather station, the wave buoy and the robotic **Thetis water profiler from May 1st to July 31st for 2021 and 2022.** Periods indicated with blank white stripes were periods where instrument maintenance was performed.
We show here water **temperature, salinity, chlorophyll A and dissolved oxygen down to roughly 50m** below the lake surface. That represents the first half of the water column below LéXPLORE. On the right hand side we plotted the differences between 2022 and 2021 for water and air variables.
For both summers, we can see nicely the warming and freshening of the water column as time moves on. We also see periods of elevated phytoplankton production, and connected with it, depths and times of elevated dissolved oxygen.

Looking at the differences between the two summers, we see that the atmospheric forcing displays higher surface pressures, higher air temperatures and higher amounts of solar radiation for pretty much the whole season.
This **atmospheric forcing impacts the lake evolution**. In 2022 we see a stronger stratification of the lake temperature, with strong positive anomalies at the lake surface and colder temperatures below. We further see a much reduced salinity in the surface layers, probably due to little to no nutrient inflow.
Counter-intuitively, even though the **summer 2022 was a record breaking heatwave summer** in Central Europe, **we do not see excessive surface algae blooming**. Instead the phytoplankton concentration stays reasonable and is highest between 10 and 20 m depth. This is also where most of the oxygen is produced.
Due to **virtually no influx of nutrients via precipitation, Rhone river discharge or surface runoff**, phytoplankton growth is limited in magnitude and location. This result shows the **complexity of investigating and predicting e.g. harmful algae blooms** in large oligotrophic lakes with climate change.

REFERENCES

Wüest, A., Bouffard, D., Guillard, J., Ibelings, B. W., Lavanchy, S., Perga, M. E., & Pasche, N. (2021). LéXPLORE: A floating laboratory on Lake Geneva offering unique lake research opportunities. Wiley Interdisciplinary Reviews: Water, 8(5), e1544.