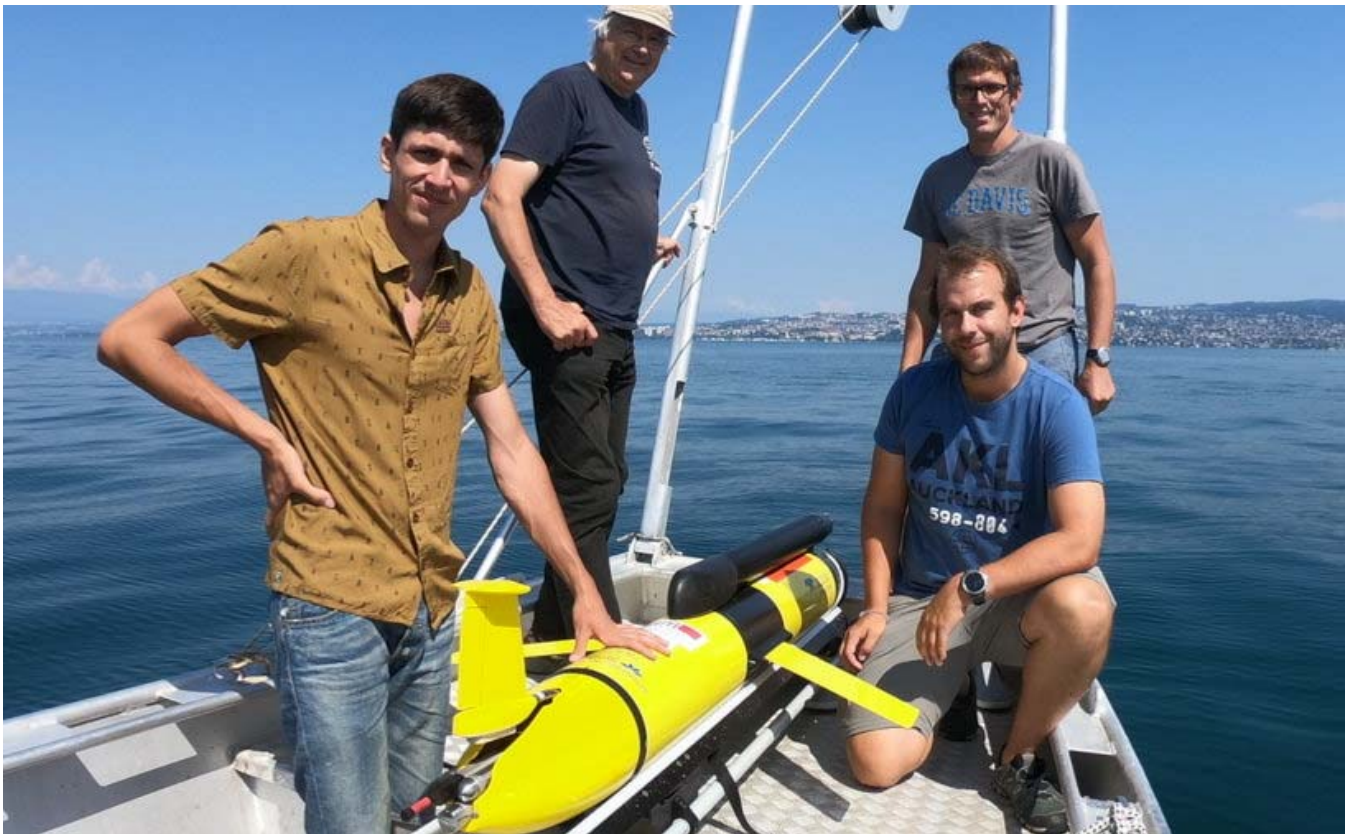


Annual Report 2018

January 2018 to December 2018

Margaretha Kamprad Chair of Environmental Science and Limnology

Physics of Aquatic Systems Laboratory APHYS at EPFL



<https://www.letemps.ch/sciences/un-robot-planeur-sousmarin-va-sonder-tourbillons-lac-leman>

1. OBJECTIVES

The aims of the *Physics of Aquatic Systems Laboratory* (APHYS) are to understand the physical processes in natural waters and the responses of aquatic systems to external forcing. The main focus is on anthropogenic influences, such as nutrient inputs, hydropower production, heat/cold use from surface waters, climate change and human activities in the catchments. We study the effects on surface waters and their sensitivity to those drivers and outline consequences for water resources management. Besides *in-situ* measurements, we apply hydrodynamic modelling and use remote sensing information.

2. RESEARCH ACTIVITIES

2.1. Oxygen depletion in Lake Geneva (SNF funded)

Lake Geneva, once the classic example of an oligotrophic alpine lake, is still recovering from excessive phosphate loading during the last 60 years. The main goal of this project is to quantify and parameterize the rate of oxygen depletion in the hypolimnion of Lake Geneva. Using a MP8 lander, oxygen microprofiles were measured at high-resolution (sub-mm scale) through the sediment-water interface to determine the flux of oxygen from the lake-water into the sediment. To determine the relative importance of different pathways of organic matter mineralization, sediment cores were taken to quantify the flux of reduced substances. The oxygen depletion in the hypolimnion is estimated based on the measured data and a simple conceptual model. The depletion rates compare well with the CIPEL long-term measurements since the 1950s.

ADCPs for small-scale measurements were deployed in close proximity in order to quantify the variations of sediment oxygen uptake as a function of bottom boundary layer currents. Using ADCP current meter records, two numerical models were calibrated to determine the currents in the bottom boundary layers of Lake Geneva and allow determining the variability of sediment oxygen uptake with bottom boundary layer dynamics for the whole lake.

A one-dimensional hydrodynamic model was used to simulate the long-term changes in deep-water mixing, which is most crucial for the supply of oxygen into the deep-waters during winter. An oxygen model including gas exchange with the atmosphere, oxygen production and oxygen depletion based on the measured currents was coupled to the hydrodynamic model.

The project was finished in February 2018, the former PhD Robert Schwefel (PhD study ended in January 2017) left with a SNF Mobility Grant to UC Santa Barbara.

2.2. Use of heat from lakes (FOEN funded)

The political goal of reducing fossil fuel consumption will increase the use of lake water for heating and cooling of riparian infrastructures. The aim of this activity is to estimate the potentials for various lakes in Switzerland. After we already performed various expert services for all larger lakes in Switzerland, and held a Peak course in November 2017 at Eawag, we concluded these activities by two reviews of the ecological and technical implications and requirements. The project concludes in September 2018.

In a related follow-up project, the expected heating of the rivers and lakes in Switzerland will be estimated and systematically evaluated. For lakes, this will include, as an example, the wintertime deep convective mixing. The project runs under the leadership of Hendrik Huwald in collaboration with Martin Schmid and Damien Bouffard (both Eawag) and it is funded by FOEN from 2017 to 2020.

2.3. Autonomous underwater robots of physical-ecological studies (SNF funded)

This Sinergia project “*A Flexible Underwater Distributed Robotic System for High-Resolution Sensing of Aquatic Ecosystems*”, under the leadership of Prof Alcherio Martinoli (EPFL) in collaboration with Prof Bas Ibelings (UniGE) is an interdisciplinary project combining AUV robot technology and

performing applied research. In a first step (2016-2017) we focused on the explanation of bio-induced mixed layers caused by excessive high concentration of upward swimming sulphur bacteria *Chromatium okenii* in Lake Cadagno. In the current stage of the project, we focus on two subprojects in Lake Zurich and Lake Geneva, respectively. The first one is about resolving the small-scale heterogeneity of the phytoplankton layer of the filamentous cyanobacteria *Planktothrix Rubescens* in the upper thermocline of Lake Zurich. For the second subproject, we study the mixing generated by the gyres that develop in Lake Geneva during summer and its effect on phytoplankton distribution. Prof. Alexander Forrest (UC Davis, USA) spent the summer 2018 as a visiting professor with APHYS. This collaboration granted the opportunity to use the UC Davis Slocum glider (cover page picture). Designed to travel long distances in the lake, the Slocum is an idoneous platform to study the lateral variability of various water quality parameters (such as temperature, algal pigments, etc) and small-scale turbulent mixing in Lake Geneva.

2.4. Lake Ladoga (Limnology Center funded)

The main goal of this sub-project is to study the development of under-ice convection in Lake Ladoga (Russia) and its implications for algae growth under ice. The Lake Ladoga project is managed by the Limnology Center and includes eight different teams from Switzerland, France, Germany and Russia. However, since the ice-cover on Lake Ladoga was too weak during March 2015, 2016, and 2017 to guarantee safe fieldwork conditions, our observations and experimental work focussed on Lake Onego instead. The study is part of an interdisciplinary research project with the aim to better characterize:

- (i) the radiative energy transfer responsible for the onset of under-ice convection,
- (ii) the vertical velocities induced by the convective cells and,
- (iii) the development of phytoplankton under ice.

Our research approach consists in collecting and analysing field data in parallel to compare observations with numerical simulations. For 2018, several joint publications in a special issue are under preparation.

In addition, a conceptual model for the mechanical energy budget in radiatively-heated ice-covered lakes was developed to quantify energy and mixing rates in such systems. The introduced and recently published framework was tested with in-situ observation collected during the field campaigns in Lake Onega. This work provides the fundamentals to continue a numerically-based research that aim to understated the under-ice water circulation resulting from radiatively-driven convection.

2.5. Hydrodynamic modelling including data assimilation (CORESIM, ESA funded)

This research project is tight to Damien Bouffard, who is building up an Aquatic Physics group at Eawag. However, the PhD student of the project remained at APHYS to complete his PhD at EPFL.

The aim of this project is to understand spatial variability of bio-geophysical processes in lakes. New information provided by remote sensing data coupled to three-dimensional models allows investigating such variability. The approach is to couple all information sources of lake research (remote sensing data, field observations and numerical models) through adapted data assimilation algorithms. The coupling of those three data sources aims at providing a new, reliable, flexible, and global modelling framework for inland waters monitoring across Switzerland, Europe and possibly expanding to other lakes of the world. To strengthen the assimilation activity, Prof Philip Chu for NOAA, Ann Arbor (Michigan), spent three months as a Visiting Prof at APHYS.

In terms of system operations, the framework will be operated in real-time for several Swiss lakes, with short-term forecasting of hydrodynamic and water quality properties, available online, and open to the public. The impacts of such systems are expected at public, governmental and scientific levels. For the latter, this project aims at contributing to advances in aquatic research by (i) identifying and studying mesoscale processes such as up- downwellings, horizontal distribution of ecological properties, and (ii) assessing the variability of lake responses to climate change, in terms of warming and ice cover.

The online platform can be viewed on www.meteolakes.ch.

3. MAJOR ACQUIRED EQUIPMENT

We had the opportunity to complete our field instrumentation with the grant from the Kamprad Chair as well as EPFL and SNF support. The acquisitions in 2018 comprise:

3.1. Two RBR Turbidity loggers

The RBR*solo Tu* loggers are compact and lightweight loggers equipped with a Seapoint Turbidity sensor with less than 2% of deviation between 0 and 750 FTU. The loggers have been deployed at Lake Cadagno to monitor the layer of the phototrophic sulphur bacteria.

3.2. Three RBR PAR loggers

The RBR*solo PAR* loggers come with LI-COR Quantum sensors. It measures Photosynthetically Active Radiation (PAR, 400-700 nm) in freshwater. The advantage of this logger is that we can easily swap hemispheric to omnidirectional LI-COR sensor for more application flexibility.

3.3. Two Chelsea Trilux sensors

The Chelsea Technologies TriLux is a low-cost, miniaturised, algae sensor capable of monitoring three different parameters (Chlorophyll-a, Phycoerythrin and Turbidity) in a single probe. It has been integrated with a Campbell logger to measure Planktothrix at different depths in Lake Zurich.

3.4. Field Peristaltic pump

The Eijkelkamp peristaltic pump, a water-sampling device specially designed for use in the field, is battery powered and microprocessor controlled. The microprocessor enables an adjustable constant water flow. It has been used to sample bellow ice-cover on Lake St-Moritz.



3.5. Bluerobotic ROV

The BlueROV2 is a high performance ROV (remotely operated vehicle) rated at 300 m. It will be mainly used for mooring inspection and mooring rescue operation. Its open source electronics allow us to modify, and improve it by adding sensors, grippers, or underwater modem.

3.6. Five PRO-Oceanus CO₂ datalogger

The Mini CO₂ probes are designed to measure dissolved CO₂. The sensor operates through rapid diffusion of gas from the liquid through an oil-resistant, advanced matrix interface to a non-dispersive infrared detector. The signal is compensated for both pressure and temperature. The Mini CO₂ probes will be mainly use in the project “Primary production under oligotrophication in lakes”.

3.7. Sonotronics Mantrak - manual tracking kit

The Mantrak kit contains a receiver and a directional hydrophone to allow tracking small transmitters installed in instruments. It will help to track instruments in case of technical issues or malfunctioning. It has been tested with the Slocum Glider on Geneva lake.

4. HUMAN RESOURCES

Theo Baracchini	PhD student since March 2015
Kevin Bärenzung	Master student, autumn semester for master thesis
Angelo Carlino	During month of August 2018 for Lago Cadagno project
Hannah Chmiel	Post-doc, since October 2016
Philip Chu	Visiting professor, July-September 2018 from NOAA, Great Lakes Environmental Research Lab, Ann Arbor, Michigan
Alexander Forrest	Visiting professor, June-September 2018 from UC Davis, USA
Daniel Forte Marques	Civil service from 17 th September to 1 st November 2018
Tania Gonin	Secretary of APHYS and LIMNC, since November 2013
Isabel Kiefer	Scientific assistant, since October 2018
Shubham Krishna	Post-doc, since May 2018 (Primary Production Project)
Sébastien Lavanchy	Technician at APHYS, since May 2015
Camille Minaudo	Post-doc since 1 st October, 2018 (Primary Production Project)
Vincent Nouchi	PhD student, from January 2014 to May 2018
Love Råman Vinnå	Post-doc since February 2018 (before PhD student, from July 2013 to January 2018); left to Eawag May 2018
Robert Schwefel	Post-doc, since February 2017 (before PhD student since January 2013); left to UC SB February 2018
Amélie Séchaud	EPFL Master student, fall 2017 to spring 2018, at l'Université du Québec à Montréal.
Oscar Sepúlveda Steiner	PhD student, since April 2016
Hugo N. Ulloa	Postdoc, since February 2017 (former U de Chile and UC San Diego).

Visitors in 2018

- **Leon Boegman**, Queen's University, Kingston, Ontario, Canada
- **Damien Bouffard**, Eawag
- **Daniel Odermatt**, Eawag
- **Philip Chu**, NOAA, Great Lakes Environmental Research Laboratory, Ann Arbor, Michigan
- **Alexander Forrest**, University of California, Davis, California, USA.
- **Craig Stevens**, National Institute of Water and Atmospheric Research(NIWA), New Zealand.

5. NETWORKING

5.1. Oxygen depletion in Lake Geneva

- Beat Müller, Damien Bouffard, Thomas Steinsberger, Eawag
- Lars Umlauf and Peter Holtermann, Institut für Ostseeforschung, Warnemünde, Germany
- Martin Wessels, Institut für Seenforschung, Langenargen, Germany

5.2. Lake Onega Project Limnology Centre, EPFL

- Natacha Tofield-Pasche, Limnology Centre, EPFL
- Arkady Terzhevik, Nikolay Filatov, Roman Zdrovenov, Nataliia Kalinkina, Natalia Belkina, Dimitry Subetto from Northern Water Problems Institute
- Bertrand Merminod, TOPO, EPFL
- Felix Schill, HYDROMEA SA
- Martinoli Alcherio, Bahr Alexander, DISAL, EPFL
- Bas Ibelings, and Daniel Ariztegui, University of Geneva:
- Marie Perga, University of Lausanne, UniL
- Victor Frossard, Camille Thomas, Emilie Lyautey from University of Savoie
- Nathalie Dubois, Mischa Haas, Damien Bouffard, Eawag
- Alexei Kouraev, LEGOS
- Hilmar Hofmann, University of Konstanz.

5.3. Lago Cadagno Project (SNF fund for Prof Tonolla)

- Mauro Tonolla, Andreas Bruder, Francesco Danza, Samuel Lüdin and Nicola Storelli, University of Applied Sciences and Arts of Southern Switzerland (SUPSI)
- Anupam Sengupta, Physics of Living Matter Group, University of Luxemburg, Luxemburg
- Damien Bouffard, Eawag

5.4. AUV applications in Lakes Zurich and Geneva (Sinergia project)

- Anwar Quraishi, Alexander Bahr and Alcherio Martinoli, DISAL, EPFL
- Felix Schill, HYDROMEA SA
- Alex Forrest and Jasmin McInerney (UC Davis, USA)
- Bas Ibelings, Ena Suarez Bolanos, Roxane Fillion, University of Geneva.
- Jakob Pernthaler and Karel Hornak, University of Zurich
- Damien Bouffard, Eawag

5.5. Remote sensing

- Daniel Odermatt, Odermatt & Brockmann GmbH, Zürich and Eawag
- Alexander Damm, Andreas Hueni and Michael Schaeppman; RSL, University of Zürich
- Damien Bouffard, Eawag
- Stefan Wunderle, University of Bern
- Tiit Kutser, Estonia

5.6. Heat use and climate warming of natural waters

- Officers from Cantons of ZH, LU, TG, SG, NW, BE as well as various engineering companies such as AquaPlus Zug.
- Hendrik Huwald and Adrien Michel, EPFL
- Damien Bouffard, Martin Schmid, Adrien Gaudard.

6. CONCLUSION AND FUTURE DIRECTIONS

Within the next four years, we envisage to pursue the following new projects:

6.1. LÉXPLORE research platform on Lake Geneva

The aim of this research platform is to acquire continuous records of physical and biogeochemical properties, as well as phytoplankton and zooplankton. This platform should also promote international

collaboration with other research groups interested in this facility. Major equipment was funded by R'Equip FNS. Since 2017, we have four partners, UniGE, UniL and Eawag besides EPFL committed to finance and operate the platform. Further core partners are welcome. The LÉXPLORE platform will be open to any scientists.

6.2. Primary productivity in large lakes

This research project started in August 2018 and is in the build-up phase. The goals are to explain the dependency of primary production (PP) on different levels of phosphorus forcing. Beside the reconstruction of primary production over the past decades, this project includes various goals related to new observations technology and new method of PP estimates over short time intervals (days). We plan to cooperate with partners on Lakes Geneva, Lugano-NB, Lugano-SB, Constance and other research institutions such as Eawag.

7. CONFERENCES IN 2018

- Baracchini, T., P. Y. Chu, D. Bouffard and A. Wüest, September 24th - September 28th, 2018. 3D Hydrodynamic and bio-physical lake models with data assimilation - Application of an operational system for Lake Geneva. **ELLS-IAGLR2018, Evian, France**
- Baracchini, T., D. Bouffard and A. Wüest, November 2018. meteolakes.ch – An online platform for monitoring and forecasting the 3D bio-physical state of Swiss lakes. **16th Swiss Geoscience Meeting, Bern 2018**
- Chmiel, H. E., Hoffmann, H., Sobek, S., and Pasche, N., June 10-15, 2018. Where does the river end? Drivers of spatiotemporal dynamics in CO₂ distribution and gas exchange in a large humic lake. **ASLO 2018 Summer Meeting, Victoria, BC, Canada**
- Chmiel, H. E., Hoffmann, H., Sobek, S., Efremova, T., and Pasche, N., September 24th - September 28th, 2018, Spatiotemporal variability in CO₂ distribution and flux in the inflow area of a large boreal lake. Big lakes – small world meeting. **ELLS-IAGLR2018, Evian, France**
- Doda T., H.N. Ulloa, A. Wüest and D. Bouffard, November 2018. Buoyancy-driven cross-shore flows in lakes induced by night-time cooling: field observations. **16th Swiss Geoscience Meeting, Bern 2018**
- Doda T., H.N. Ulloa, A. Wüest and D. Bouffard. Cross-shore buoyancy-driven flows in lakes due to night-time cooling: field observations, August 2018. **21st International Workshop on Physical Processes in Natural Waters, Solothurn, Switzerland, <http://www.unige.ch/PPNW2018/>**
- Dubois, N., L. Råman Vinnå, M. Rabold, M. Hilbe, F.S Anselmetti, A. Wüest, L. Meuriot, A. Jeannet and S. Girardclos, November 2018. Subaquatic slope instabilities due to river correction and artificial dumps (Lake Biel, Switzerland). **16th Swiss Geoscience Meeting, Bern 2018**
- Kobler U.G., M. Schmid and A. Wüest. Will climate change enhance the effects of pumped-storage on the thermal properties of the connected water bodies?, August 2018 **21st International Workshop on Physical Processes in Natural Waters, Solothurn, Switzerland, <http://www.unige.ch/PPNW2018/>**
- Odermatt, D., G. Lieberherr, D. Bouffard, S. Wunderl^e, H. Ganz, Vincent Nouchi, T. Baracchini, C. Brockmann, and A. Wüest. Validating the thermal forcing of an integrated monitoring system for Lake Geneva. **13-15 March 2018 Sentinel-3 Validation Team Meeting. Darmstadt, Germany,.**
- Råman Vinnå L., D. Bouffard, A. Wüest, S Girardclos, and N. Dubois, April 2018. Spatial focusing of lake sedimentation by wind driven circulation. **EGU 2018 session: HS9.4/SSS13.38 Transfer of sediments and contaminants in catchments, rivers systems and lakes.**

- Råman Vinnå L., A. Wüest, M. Schmid., and D. Bouffard, Climate reaction of lakes affected by global and local anthropogenic influences, August 2018. **21st International Workshop on Physical Processes in Natural Waters, Solothurn, Switzerland**, <http://www.unige.ch/PPNW2018/>
- Sepúlveda Steiner, O., D. Bouffard, F. Schill, and A. Wüest, June 2018, Measuring bio-convection in natural waters. **8th International Symposium on Environmental Hydraulics, University of Notre Dame, Indiana, USA**, <https://ceees.nd.edu/iseh2018>
- Sepúlveda Steiner, O., D. Bouffard, and A. Wüest, August 2018, Day and night bio-convection in Lake Cadagno. **21st International Workshop on Physical Processes in Natural Waters, Solothurn, Switzerland**, <http://www.unige.ch/PPNW2018/>
- Sepúlveda Steiner, O., A. Forrest, J. McInerney, T. Baracchini, S. Lavanchy, D. Bouffard and A. Wüest, November 2018. Basin-scale gyres: Rotationally-driven mixing in Lake Geneva. **16th Swiss Geoscience Meeting, Bern 2018**
- Ulloa, H.N., A. Wüest, and D. Bouffard. August 20 – August 24, 2018. Mechanical energy budget and mixing efficiency for a radiatively forced ice-covered freshwater basin. **21th Physical Processes in Natural Waters Workshop**, Solothurn, CH
- Wüest, A., 16 Februar 2018, Vierwaldstättersee - ein reichhaltiges Ökosystem mit besonderem Charakter. Talk. **SKS Clublokal Stansstad, NW, Swiss Offshore Yachting**
- Wüest, A., 14 July 2018, Heizen und Kühlen mit Wasser aus Seen. Talk. **Rotary Club, Luzern. Restaurant National Luzern**
- Wüest A., 21 August 2018. Why is deepwater oxygen depletion not decreasing despite reoligotrophication? **21st International Workshop on Physical Processes in Natural Waters, Solothurn, Switzerland**, <http://www.unige.ch/PPNW2018/>
- Wüest A, 28-29 May 2018. Using surface waters for heat management. ADDRESSING the ENERGY-WATER NEXUS., Brussel. **IEA Experts' Group on R&D Priority Setting and Evaluation**
- Wüest A., M.E. Perga, B. Ibelings, D. Bouffard, and N. Pasche. 26 September 2018. LéXPLORE – the research platform for high-resolution measurements on Lake Geneva. Big lakes – small world meeting. **ELLS-IAGLR2018, Evian, France.**

8. PUBLICATIONS IN 2018

8.1. Published peer-reviewed papers in 2018

- Bouffard, D., I. Kiefer, A. Wüest, S. Wunderle, and D. Odermatt (2018). Are surface temperature and chlorophyll in a large deep lake related? An analysis based on satellite observations in synergy with hydrodynamic modelling and in-situ data. *Remote Sensing of Environment* **209**: 510–523, doi: 10.1016/j.rse.2018.02.056.
- Bouffard, D. and A. Wüest (2019). Convection in Lakes. *Annu. Rev. Fluid Mech.* **51**: 189–215. doi: 10.1146/annurev-fluid-010518-040506.
- Kobler, U.G., A. Wüest, and M. Schmid (2018). Effects of lake-reservoir pumped-storage operations on temperature and water quality. *Sustainability* 2018, **10**(6): art no 1968, doi:10.3390/su10061968.
- Nouchi, V., D. Odermatt, A. Wüest, and D. Bouffard (2018). Effects of non-uniform vertical constituent profiles on remote sensing reflectance of oligo- to mesotrophic lakes. *European Journal of Remote Sensing* **51**(1): 808–821, doi: 0.1080/22797254.2018. 1493360.
- Råman Vinnå, L., A. Wüest, M. Zappa, G. Fink and D. Bouffard (2018). Tributaries affect the thermal response of lakes to climate change. *Hydrol. Earth Syst. Sci.*, **22**(1): 31–51, doi: 10.5194/hess-22-31-2018.
- Schwefel, R., T. Steinsberger, D. Bouffard, L.D. Bryant, B. Müller, and A. Wüest (2018) Using small-scale measurements to estimate hypolimnetic oxygen depletion in a deep lake. *Limnology and Oceanography* **63**: S54–S67, doi: 10.1002/lno.10723.

- Ulloa, H.N., A. Wüest, and D. Bouffard (2018). Mechanical energy budget and mixing efficiency for a radiatively heated ice-covered waterbody. *Journal of Fluid Mechanics* **852**: R1. doi:10.1017/jfm.2018.587.
- Ulloa, H.N., Davis, K.A. Davis, S.G. Monismith, and G. Pawlak (2018). Temporal variability in thermally-driven cross-shore exchange: the role of semidiurnal tides. *Journal of Physical Oceanography*. <https://doi.org/10.1175/JPO-D-17-0257.1>
- Rojas, P., H.N. Ulloa and Y. Niño (2018). Evolution and decay of gravity wavefields in weak-rotating environments: a laboratory study. *Environmental Fluid Mechanics*; <https://doi.org/10.1007/s10652-018-9609-5>.

8.2. Published non-peer-reviewed papers in 2018

- Gaudard A., M. Schmid und A. Wüest (2018a). Utilisation thermique des eaux superficielles – Potentiel des lacs et rivières Suisses. *Aqua & Gas - Fachzeitschrift für Gas, Wasser und Abwasser* **98**(6): 74 - 81.
- Gaudard A., M. Schmid und A. Wüest (2018b). Thermische Nutzung von Seen und Flüssen – Potential der Schweizer Oberflächengewässer. *Aqua & Gas - Fachzeitschrift für Gas, Wasser und Abwasser* **98**(2): 26 - 33.

8.3. Submitted manuscripts to peer-reviewed Journals in 2018

- Baracchini, T., M. Verlaan, R. Uittenbogaard, A. Cimadoribus, A. Wüest and D. Bouffard (2018). Automated calibration of 3D hydrodynamic models using the OpenDA data assimilation platform. *Geophysical Model Development* (to be submitted).
- Baracchini, T., P. Y. Chu, G. Lieberherr, S. Wunderle, M. Verlaan, A. Wüest and D. Bouffard (2018). Temperature data assimilation to 3D lakes hydrodynamic models (2018). *Geophysical Model Development* (to be submitted).
- Bouffard, D. G. Zdorovenova, S. Bogdanov, T. Efremova, S. Lavanchy, N. Palshin, A. Terzhevik, L. Råman Vinnå, S. Volkov, A. Wüest, R. Zdorovenov, H. N. Ulloa. Under-ice convection dynamics in a lake. *Inland Waters* (revised).
- Chmiel, H. E., Hoffmann, H., Sobek, S., Efremova, T., and N. Pasche. Where does the river end? Drivers of spatiotemporal variability in CO₂ distribution and flux in the inflow area of a large boreal lake. *Limnology and Oceanography* (submitted).
- Gaudard, A., A. Wüest, M. Schmid (2019). Using lakes and rivers for extraction and disposal of heat: Estimate of regional potentials. *Renewable Energy, RENE-D-18-00711* (revised).
- Dubois, N., L. Råman Vinnå, M. Rabold, M. Hilbe, F.S Anselmetti, A. Wüest, L. Meuriot, A. Jeannet and S. Girardclos (2018). Subaquatic slope instabilities: the aftermath of river correction and artificial dumps in Lake Biel (Switzerland). *Sedimentology* (submitted).
- Kobler, U.G., A. Wüest, and M. Schmid (2018). Combined effects of pumped-storage operation and climate change on thermal structure and water quality. *Climatic Change* (submitted).
- Soomets, T., T. Kutser, A. Wüest and D. Bouffard (2019). Decennial spatial and temporal changes of primary productivity in a deep peri-alpine lake. *Inland Waters* (accepted).
- Ulloa, H.N., G. Constantinescu, K. Chang, D. Horna-Munoz, O. Sepúlveda-Steiner, D Bouffard, and A. Wüest. Hydrodynamics of a periodically wind-forced small and narrow stratified basin: A large-eddy simulation experiment. *Environmental Fluid Mechanics*. ID: EFMC-D-18-00074. (revised).

8.4. Reports and expert services in 2018

None

9. TEACHING

9.1. Courses

- **Limnology**, Master course, spring term 2018, ENV-425, Env. Engineering, EPFL.
- Supervision of several students of the **Minor STAS program**: Planning and preparation of fieldwork in the Kara Sea (Russia) and reporting.

9.2. PhD Student supervised 2018

- Vincent Nouchi. Remote sensing of optical water properties; exam April 2018
- Theo Baracchini. Hydrodynamic modelling and assimilation of remote sensing data; ongoing
- Ulrike Kobler. Effects of pump storage operation on lakes; exam December 2018
- Oscar Sepúlveda Steiner. Resolving horizontal structures in lakes; ongoing
- Severin Stähly. Hydropower impact - linking biological and hydromorphological characteristics
- Sara Venuleo. Sediment-induced density flows; ongoing.
- Tomy Doda. Convective flows; since February 2018.

9.3. PhD Student exams in 2018

- Zordan J. (2018). Geomorphic work by gravity currents with varying initial conditions. *PhD thesis EPFL nr 8'322*. Examiner president (Examiners: A. Schleiss, M. Franca, D. Bouffard, B.C. Kneller, and B. Spinewine).
- Schlögl S. (2018). Investigation of snow melt dynamics and boundary layer processes over a melting snow surface. *PhD thesis EPFL nr 8529*. Examiner (other examiners: M. Lehning, R. Mott-Grünewald, S. Hoch, M. Rotach).
- Rahaghi A.I. (2018). Large-scale and meso-scale surface heat flux patterns of Lake Geneva. *PhD thesis EPFL nr 8650*. Examiner (other examiners: Nicolas Le Dantec, Alexis Berne, Gregoire Mariethoz)
- Nouchi V (2018). Toward a systematic integration of optical remote sensing for inland waters studies. *PhD thesis EPFL nr 8'622*. Examiner. (D. Bouffard, D. Odermatt, T. Kutser, F. Golay).
- Kawka M. (2018). Application of Ensemble Kalman Filter in modelling of water reservoirs hydrodynamics. *PhD thesis Warsaw University of Technology*. Co-examiner.

9.4. Master students in 2018

- Amrari Sélim (February 2018). Remote-sensing and classification of benthic landscapes for satellite derived bathymetry (*Supervisors*: Dr. Hugues Lemonnier, Romain Le Gendre, Benoit Soulard). LEADNC, IFREMER - New Caledonia.
- Séchaud Amélie (June 2018). Methane accumulation and oxidation under-ice in various lakes in Québec. (*Supervisors*: Prof Yves Prairie). Université du Québec à Montréal.
- Pontos-Dami Josquin (July 2018). Influences of climate change on Winter Mixing Depth and dissolved oxygen concentration in Lake Lugano. (*Supervisors*: Love Râman Vinnå (Eawag), Fabio Lepori (SUPSI), and Patrick Della Croce (FUS)).

10. CURRENT EXPERT AND CONSULTING ACTIVITIES

- Member of the Eawag Directorate
- Member of Doctoral Program in Civil and Environmental Engineering (since 2014)
- Member of Advisory Board to the Swiss Competence Centre for Energy Research
- Member of Advisory Board to Forschungsstelle Nachhaltige Energie- und Wasserversorgung, University of Basel
- ContourGlobal, Methane extraction in Lake Kivu, external advisor

- Co-editor of Aquatic Sciences
- Member of the Scientific/Technical Board for Lake Restoration on the Swiss Plateau, ASSAN
- Member of Group of Expert for IGKB (Lake Constance International Commission (Sachverständiger).

11. PROPOSALS

New, pending

- None

Recent on-going funding

- **Primary production under oligotrophication in lakes**. Alfred Wüest (responsible). SNF grant 200021_179123, 1. August 2018 to 31 July 2021. Internal EPFL number 514 254. Total amount: 547'560 CHF.
- **Heterogeneous data platform for operational modeling and forecasting of Swiss lakes (DATALAKES)**, Sykus and Bouffard (Eawag), Wüest (EPFL) and Siddhartha Mishra, ETH Zurich. Swiss Data Science Center
- NCCS Hydro-CH2018 – Research Project: **Evolution of stream and lake water temperatures under climate change**. Hendrik Huwald and Alfred Wüest (EPFL) and Damien Bouffard and Martin Schmid (Eawag), FOEN, Swiss Federal Office for Environment.
- **A Flexible Underwater Distributed Robotic System for High-Resolution Sensing of Aquatic Ecosystems**, Alcherio Martinoli (responsible), Alfred Wüest, Bastiaan Ibelings (Uni Geneva), CRSII2_160726, *SINERGIA*, SNF, 386'304 kF (Total amount = 1,675 kF).
- **CORESIM, CO**upling **RE** mote **S**ensing, In situ and **MO**deling data for inland waters, Bouffard D. (EPFL), Odermatt D (Odermatt and Brockmann GmbH), Anneville O (UMR CARTELE) and A. Wüest (EPFL), ESA, 2016 - 2018.
- **Kivu Monitoring project**, Hydrodynamic modelling of Lake Kivu (EDMC/LKMP, Rwanda); PI: Deltares, NL, Damien Bouffard (EPFL), started in 2016.

Recently finished

- **Léman exploration LÉXPLORE**, Research Equipment / SNF - R'Equip 2014, Alfred Wüest, Natacha Tofield-Pasche, Bastiaan Ibelings (Uni Geneva), Swiss National Science Foundation, 680 kF (split with Uni Geneva). Grant 206021_157779, period = 01.05. 2015 to 30.04.2017 (2x12 months). Ended April 2017.
- **Oxygen depletion in a deep perialpine lake**, SNF Grant 200020_165517; period = 1.7.2016 to 31.12.2017, 146 kF.
- **Life under the ice in Lake Ladoga**; 109 kF; contribution from the Limnology Center (external sponsoring by FEEL Foundation); total 1,300 kF; dossier number: 9660, Internal project : 531,254 (01.12.2014 au 30.11.2017). Ended November 2017.