

# Annual Report 2016

January 2016 to December 2016

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**Chair of Environmental Science and Limnology**

**Physics of Aquatic Systems Laboratory**  
**APHYS at EPFL & Eawag**



## 1. OBJECTIVES

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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 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

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### 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 are 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 of oxygen depletion. The results compare well with the CIPEL long-term measurements since the 1950s.

Small-scale ADCPs are 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 are 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.

### 2.2. Particles distribution in Lake Biel (ESB funded)

The City of Biel uses lake-water as part of the drinking water supply. In December 2009 extremely high particle concentrations forced the temporary shut-down of the Ipsach/Bienne drinking water treatment plant for the first time since more than ~30 years of operation. The objective of this project is to investigate the causes behind such events and to determine the potential of reoccurrence of such phenomena. The processes governing the lateral distribution of particles within the lake and how the particles are affected by anthropogenic influences will be investigated using numerical modelling in one and three dimensions. The origin of the particles (mainly Aare at Hagneck and La Suze at Biel) and the lateral distribution patterns will be determined and correlated to the model results using state-of-the-art techniques and equipment (ADCP, Aquadopp – high resolution current meters; LISST – multi-parameter system for *in-situ* observations of particle size distribution and volume concentration; high resolution temperature logger). The project results are intended to provide guidance for the planned major refurbishing of the water treatment plant and intake system used by the City of Biel.

### 2.3. Satellite-based monitoring of chlorophyll and temperature on Lake Geneva

Since 1957, the water quality of Lake Geneva has been monitored at different locations and since several years, two locations are still measured bimonthly by the *Commission Internationale pour la Protection des Eaux du Léman* (CIPEL). However, phytoplankton growth changes daily and more suitable methods to monitor chlorophyll concentrations should be developed for the future. Satellite images from the MERIS sensor on the ENVISAT mission have been used to analyse the chlorophyll variability in space and time from 2002 to 2012. In a second step, images from the AVHRR sensor on the NOAA and MetOp missions were considered. These surface temperature images were treated by the Oeschger Center for Climate Change Research, University of Berne, and used in this study.

During the summer months, when stratification reaches its maximum, nutrient concentrations in the surface layers sink to the minimum. When comparing lake surface temperature and chlorophyll concentration patterns, some episodes were found where algal growth can be related to a previous upwelling event, bringing colder and nutrient-richer water to the surface. Such relations are analysed in order to understand the interdependencies between physical and biological processes in lakes.

### 2.4. Use of heat from lakes (expert service)

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, such as Lake Lucerne, Lake Constance or the large lakes of Canton Bern (see publications below). The questions to be answered concern the ecological and technical requirements for lakes, particularly in view of climate warming. Of special interest are effects on the temperature and stratification which are evaluated by one-dimensional k-epsilon modelling for various forcing scenarios.

For nearly 30 years, EPFL has been using water from Lake Geneva to provide yearlong heating and cooling for the EPFL/UniL campus buildings and infrastructure. The system is recently reaching its capacity limits and encountering related problems. The objective of this project was to provide recommendations for the renovation of the installation. Different alternatives are proposed for the sustainable heat use over the next four decades.

### 2.5. Observation of mixing by sulphur bacteria in Lago Cadagno

This project focuses on the explanation for the astonishing observation of a completely mixed layer in Lago Cadagno (Ticino, Switzerland) in a depth of ~12 m within the 20 m deep lake. Excessive high concentration of sulphur bacteria (*Chromatium okenii*) lead to homogenise a layer of ~1 m thickness within the strong stratification at the oxic-anoxic interface in ~12 m depth. The mechanical energetics of the mixing – most probably caused by the swimming bacteria – is subject of the research which comprises field observations (profiling of biogeochemical concentrations and temperature microstructure / turbulence) and direct numerical simulations. In summer 2017, we try again to map the two-dimensional structure of the bacterial layer by using AUV robots.

### 2.6. Lake Ladoga (Limnology Center funded)

The main goal of this sub-project is to study the development of under-ice convection in Lake Ladoga and its implications for algae growth under ice. The Lake Ladoga project is managed by the Limnology Center and includes eight different teams from several countries (see list below). In March 2015, the first fieldwork was performed on Lake Onega, as the ice-cover on Lake Ladoga was too weak. Also in 2016 the ice was again not strong enough for Lake Ladoga and the work focussed on Onega. The study is part of an interdisciplinary research project with the aim to better characterize:

- (i) the radiative 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 large eddy simulations.

## **2.7. Hydrodynamic modelling including data assimilation (CORESIM, ESA funded)**

This research project aims at coupling 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.

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 system 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. A first part of the project is funded by an approved ESA grant.

## **3. MAJOR ACQUIRED EQUIPMENT**

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We had the opportunity to complete our field instrumentation with the grants from the Kamprad Chair as well as EPFL/ENAC resources. The two pictures below show two key items acquired in 2013: the aluminium research boat (left) and the oxygen microprofiler (right). The acquisitions in 2016 comprise:

### **3.1. Campbell scientific dataloggers with GSM/GPRS communication**

Campbell scientific dataloggers are reliable and versatile data acquisition system with programming capabilities. A CR6 is installed at the Buchillon mast to control the weather station and it will be able to control different underwater instrument (ADCP, CO<sub>2</sub> sensor, temperature logger, etc..) in real time. A CR800 is used at the laboratory for test purpose, and a CR300 for small deployment application.

### **3.2. Two RBR Turbidity loggers**

The RBR*solo Tu* loggers are compact and light-weight single channel turbidity loggers with less than 2% of deviation between 0 and 750 FTU. Two loggers have been used at Cadagno lake to monitor the layer of the phototrophic sulphur bacteria.

### **3.3. Two RBR real time temperature loggers**

The RBR *solo/rt T* is a real time temperature logger controlled via serial communication with an accuracy of  $\pm 0.002^{\circ}\text{C}$ . It is now installed at the Buchillon mast in parallel with the PT100 temperature sensor for a better accuracy.

### **3.4. Four RBR temperature depth loggers**

The RBR*duet TD* loggers are compact and light-weight two channels depth and temperature loggers with an accuracy of  $\pm 0.002^{\circ}\text{C}$  for temperature and 0.05% full scale for pressure. Those loggers are able to record minuscule change of pressure at 4 Hz sampling rate. It has been used on Lake Onego just below the ice cover to measure the movement of the cracks in the ice.

### **3.5. Hart 7320 temperature calibration bath**

The Hart 7320 temperature calibration bath has a stability and uniformity less than  $0.005^{\circ}\text{C}$ . The main goal of this equipment is the accurate calibration of commercial temperature sensors to the maximum possible.



### 3.6. Niskin water sampler

Niskin-type plastic water sampler consisting of a tube with two lids connected by a latex rubber tubing. The lids are kept open during descent to flush the sampling volume of then bottle. A messenger, dropped down from the surface, releases the end stoppers for closure.

### 3.7. Two infrared radiation Pyrometer

The Infrared Radiation Pyrometer KT15.85 IIB is a measuring transducer, which receives the infrared radiation emitted by the lake surface and transforms it into a standardized output signal. The pyrometer is installed at the Buchillon mast and the data is sent in real time.

## 4. HUMAN RESOURCES

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<b>Theo Baracchini</b>	PhD student since March 2015
<b>Damien Bouffard</b>	Scientist and supervisor of PhD students, since November 2012
<b>Christel Chappuis</b>	Master student autumn 2016 in APHYS, EPFL
<b>Oriane Etter</b>	Master student autumn 2016 in APHYS, EPFL
<b>Tania Gonin</b>	Secretary of APHYS and LIMNC since November 2013
<b>Fabrizio Gonzales Zurita</b>	Master student, spring 2016 in APHYS, EPFL
<b>Miki Hondzo</b>	Visiting Professor, University of Minnesota, Minneapolis from 1 January to 30 April 2016
<b>Sébastien Lavanchy</b>	Technician at APHYS (EPFL); since 15 May 2015

<b>Vincent Nouchi</b>	PhD student since January 2014, project “ <i>ULM Leman-Baikal</i> ”
<b>Daniel Odermatt</b>	Scientist (10%) at Eawag, various projects on Remote Sensing
<b>Iliia Ostrovsky</b>	Visiting Professor, Israel Oceanographic and Limnological Research (IOLR) from 1 April to 30 June 2016
<b>Angela Phor</b>	Visiting Master student, University of Pierre & Marie Curie (UPMC), 1 May to 31 August 2016
<b>Michael Plüss</b>	Technician at Eawag (80%); since 1 June 2015
<b>Love Råman Vinnå</b>	PhD student since July 2013, project “Particles in Lake Biel”
<b>Perrine Ratouis</b>	Master student in Autumn 2015 / Spring 2016 (UC Davis, Lake Tahoe)
<b>Eliane Scharmin</b>	Secretary of APHYS group at Eawag
<b>Robert Schwefel</b>	PhD student since January 2013, project “ <i>Oxygen depletion in Lake Geneva</i> ”
<b>Oscar Rodrigo Sepúlveda Steiner</b>	PhD student since April 2016, project “A Flexible Underwater Distributed Robotic System for High-Resolution Sensing of Aquatic Ecosystems”
<b>Tobias Sommer</b>	Postdoc since May 2014 in project “ <i>Double diffusion in Lake Kivu</i> ” and bacterial layer in Lago Cadagno
<b>Stan Thorez</b>	Visiting Master student, Eindhoven University of Technology, 15 April to 30 June 2016
<b>Oliver Truffer</b>	Intern at APHYS (Eawag, KB); 1 May to 31 July 2016
<b>Alfred Wüest</b>	Head of APHYS Eawag and APHYS EPFL (since Sep 2012)
<b>Martin Zoller</b>	Civil servant at APHYS EPFL; 1 Oct 2016 to 15 Feb 2017
<b>Roman Zoller</b>	Civil servant at APHYS EPFL; 29 February to 18 June 2016

## Visitors in 2016

- **Peter Holtermann**, Institut für Ostseeforschung, Warnemünde, Germany
- **Robert Uittenbogaard**, DeltaRes, Delft Holland
- **Cynthia Bluteau**, University of Western Australia

## 5. NETWORKING

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### 5.1. Oxygen depletion in Lake Geneva

- Lee Bryant, University of Bath, UK
- Miki Hondzo, University of Minnesota, USA
- Beat Müller, and Thomas Chwalek, Eawag
- Elena Sanchez, Universidad de Granada, Spain
- Lars Umlauf, and Peter Holtermann, Institut für Ostseeforschung, Warnemünde, Germany

## 5.2. Particles distribution in Lake Biel

- Roland Kaeser, Energy Service Biel (ESB), Waterworks City of Biel
- Natalie Dubois, Eawag
- Flavio Anselmetti and Michael Hilbe University of Bern.

## 5.3. Lake Onega Project Limnology Centre, EPFL

- Natacha Tofield-Pasche, Limnology Centre, EPFL
- Arkady Terzevik, Nikolay Filatov, Roman Zdorovenov, Nataliia Kalinkina, Natalia Belkina, Dimitry Subetto from Northern Water Problems Institute
- Kevin Barbieux, Bertrand Merminod, TOPO, EPFL
- Felix Schill, Martinoli Alcherio, Bahr Alexander, DISAL, EPFL
- Bas Ibelings, Marie-Caroline Tiffay, and Daniel Ariztegui, University of Geneva:
- Marie Perga, INRA Thonon-les-Bains
- Victor Frossard, Camille Thomas, Emilie Lyautey from University of Savoie
- Nathalie Dubois, Mischa Haas from Eawag
- Alexei Kouraev from LEGOS
- Hilmar Hofmann from University of Konstanz.

## 5.4. Lago Cadagno Project

- Mauro Tonolla, Francesco Danza, University of Applied Sciences and Arts of Southern Switzerland (SUPSI)
- Anupam Sengupta, Stocker's Microfluids Laboratory ETHZ
- George Constantinescu, The University of Iowa, USA
- Talia Tokyay, Middle East Technical University, Ankara, Turkey
- Caroline Buckner, Jasmine Berg, MPI Bremen, Germany
- Helmut Bürgmann, Carsten Schubert, Eawag

## 5.5. Remote sensing

- Yosef Akhtman and Bertrand Merminod, TOPO, EPFL, Lausanne
- Daniel Odermatt, Brockmann-Consult, Zürich
- SEON: Alexander Damm and Andreas Hueni; Geography Institute, University of Zürich
- Stefan Wunderle, University of Bern
- Peter Hunter, Stirling U., UK
- Tiit Kutser, Estonia

## 5.6. Heat use expert service

- Officers from Cantons of ZH, LU, TG, SG, NW, BE as well as various engineering companies such as AquaPlus Zug.

## 6. CONCLUSION AND FUTURE DIRECTIONS

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

### 6.1. Sinergia project on underwater robots for high-resolution spatial mapping

This interdisciplinary project - a collaboration with Prof Bas Ibelings from UNIGE and Prof Alcherio Martinoli from the DISAL Laboratory at EPFL aims at using underwater automatic vehicles to investigate the spatial heterogeneity of physico-biological processes in lakes. The proposal was submitted by 15 January 2015 to FNS and was approved. The project started in August 2015.

### 6.2. Research platform on Lake Geneva

The aim of this research platform is to acquire continuous records of physical properties, biogeochemical processes, as well as phytoplankton and zooplankton. This platform should also promote international collaboration with other research groups interested in this facility. The equipment will be part of a R'Equipe proposal submitted in May 2014 to FNS, which subsequently approved the request. End of 2016, we have four partners, UniGE, UniL and Eawag besides EPFL interest in the financing and operation of the platform.

### 6.3. Coupling RS, in situ and three dimensional model

The aim of this project is to understand the spatial variability of bio-geophysical processes in lakes. Lateral extent was difficult to investigate in the past with classical moorings and the new information provided by satellite data coupled to three-dimensional models now allow to investigate such variability. Two main axis are (i) retrieval of inland water optical properties, (ii) data assimilation of remote sensing data into models.

### 6.4. Primary productivity in large lakes

During 2017 we aim at building up a research project including partners from Germany, France and Italy to study short-term and long term (decades) primary productivity processes in lakes as a function of the declining phosphorus content in lakes.

## 7. CONFERENCES IN 2016

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Barbieux K., V. Nouchi, and B. Merminod 2016. Airborne hyperspectral sensor radiometric self-calibration using near-infrared properties of deep water and vegetation, *Proc. SPIE 9999, Remote Sensing of the Ocean, Sea Ice, Coastal Waters, and Large Water Regions 2016*, 99990M (October 19, 2016); doi:10.1117/12.2241251.

Bouffard, D. I. Kiefer, A. Wüest, and D. Odermatt, May 2016, A case study of physical processes controlling spatial variability of chlorophyll-a in a large lake (Lake Geneva). Poster. "Physical-biological interactions - implications for biogeochemistry, productivity, export, diversity and transport", **48th Liege colloquium, Liege 2016**.

Kiefer, I., A. Wüest, D. Odermatt, D. Bouffard, 7 September 2016, *Linkage of Phytoplankton Abundance and Surface Temperature in Lake Geneva*. Poster, at the **Colour and Light in the Ocean from Earth Observation (CLEO) Workshop 2016**, ESA-ESRIN, Frascati, Rome (Italy).



- Nakhaei, N., L Boegman, D Bouffard. 2 September 2016. *Measurement of vertical oxygen flux in lakes from microstructure casts*. **Proceedings 8th Int. Symp. on Stratified Flows**, San Diego, USA
- Nouchi V., D. Bouffard, D. Odermatt, J. Pitarch, P. Hunter, A. Wüest, 7 September 2016, *Spatial variability of Inherent Optical Properties in the perialpine lakes*. Poster, at the **Colour and Light in the Ocean from Earth Observation (CLEO) Workshop 2016**, ESA-ESRIN, Frascati, Rome (Italy).
- Odermatt, D., D. Bouffard, T. Baracchini, und A. Wüest, 7 September 2016, *Coupling Inland Water Remote Sensing, In situ Data and Models*. Poster, at the **Colour and Light in the Ocean from Earth Observation (CLEO) Workshop 2016**, ESA-ESRIN, Frascati, Rome (Italy).
- Råman Vinnå L., A. Wüest and D. Bouffard 12-15 July, 2016 Impact of nuclear produced thermal pollution on a lake with short residence time - what can models resolve? Talk at **19<sup>th</sup> Workshop on Physical Processes in Natural Waters**, Bath, UK.
- Schmid M., and A. Wüest, July 2016, *Methane extraction from Lake Kivu: a case study for model-based policy*. Talk, **iEMSs 2016, The role of modelling in sustainable development**, Toulouse France.
- Schwefel R. et al. 20 Apr 2016. *Effects of climate change on deep-water oxygen and winter mixing in a deep lake (Lake Geneva)*. **EGU General Assembly 2016, Session HS10.2 - Lakes and inland seas in a changing environment EGU2016-4177**. Vienna
- Sommer T., G.S. Constantinescu and A. Wüest, 3-7 April, 2016. *Bacteria induced mixing in natural waters*. **CSF Conference "Fluid Mechanics and Collective Behavior: From Cells to Organisms"** Conference Centre Monte Verita in Ascona.
- Soomets T., T. Kutser, H Arst, T. Noges and A. Wüest. 7 September 2016, *Application Of A Satellite Data Based Bio-optical Primary Production Model On Large Lakes?* Poster, at the **Colour and Light in the Ocean from Earth Observation (CLEO) Workshop 2016**, ESA-ESRIN, Frascati, Rome (Italy).
- Wüest, A., 24. Oktober 2015, *Potenzial Seewasser in der Schweiz*. Grobkonzept „**Energie-Ring-Tag**“ (V2) Energie-Ring Küssnacht in Immensee. Talk, Immensee Dorfzentrum und See.
- Wüest, A., T. Sommer, J.R. Carpenter and M. Toffolon, 9-13 November, 2015, *Insights from investigating double-diffusive convection in deep and strongly stratified lake*. **Workshop on Double Diffusion**. Talk, BIRS (Bamf IMF), Casa Matemática Oaxaca, Mexico.
- Wüest, A., G.S. Constantinescu and D. Bouffard. 21 November 2015, *Potentials and limits of three-dimensional modelling in lakes*. **Swiss Geoscience Meeting: Hydrology, Limnology and Hydrogeology**, Invited talk, University Basel.
- Wüest, A. 30 Mai 2016, *Wie fit ist der Bodensee für den Klimawandel?* **Festkolloquium 60 Jahre Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA)**, „Klimawandel – Folgen und Anpassungsstrategien der Wasserwirtschaft“, Talk, Langenargen.
- Wüest, A., 7. June 2016, *No Quick Fix to Hypoxia: A Long Time-Scale Exercise*. **IAGLR Meeting, University Guelph, Ontario, Canada**. Plenary talk.
- Wüest A., 14 July 2016, *20 years of PPNW: Ever-growing interest in the geosciences of inland water?* Invited plenary talk, **Workshop PPNW**, University of Bath.
- Wüest A., M. Schmid und A. Gaudard, 6 September 2016, *Heizen und Kühlen mit Wärme aus Seen*. **Eawag Infotag 2016**, Verkehrshaus Luzern.
- Wüest A., L. Råman Vinnå, N Dubois und F.S. Anselmetti, 22 November 2016, *Untersuchungen und Strömungsmodell Bielersee*. **Schlussveranstaltung zum Projekt Bielersee**, ESB Biel.

## 8. PUBLICATIONS IN 2016

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### 8.1. Published peer-reviewed papers in 2016

- Berg, P., D.J. Koopmans, M. Huettel, H. Li, K. Mori, and A. Wüest (2016). A new robust oxygen-temperature sensor for aquatic eddy covariance measurements. *Limnology and Oceanography: Methods* **14**(3), 151–167, doi: 10.1002/lom3.10071.
- Bouffard, D., R.E. Zorovenov, G.E. Zorovenova, N. Pasche, A. Wüest and A.Y. Terzhevik (2016). Ice-covered Lake Onega: effects of radiation on convection and internal waves. EUROPEAN LARGE LAKES IV, *Hydrobiologia* **780**: 21–36, doi: 10.1007/s10750-016-2915-3.
- Bouffard, D., and M.E. Perga Are flood-driven turbidity currents hot spots for priming effect in lakes? *Biogeosciences* **13** (12), 3573-3584.
- Bruder, A., D. Tonolla, S.P. Schweizer, S. Vollenweider; S.D. Langhans, and A. Wüest, (2016), A conceptual framework for hydropeaking mitigation, *Science of the Total Environment*, **568**: 1204–1212, doi: 10.1016/j.scitotenv.2016.05.032.
- Fink, G., M. Wessels and A. Wüest (2016). Flood frequency matters: Why climate change degrades deep-water quality of peri-alpine lakes, *Journal of Hydrology* **540**: 457–468 doi: 10.1016/j.jhydrol.2016.06.023.
- Graham, N.D., D. Bouffard, J.L. Loizeau (2016). The influence of bottom boundary layer hydrodynamics on sediment focusing in a contaminated bay *ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH*, **23** (24): 25412-25426, doi: 10.1007/s11356-016-7715-9
- Razmi, A.M., U. Lemmin, D. Bouffard, A. Wüest, R.E. Uittenbogaard and D.A. Barry (2016). Gyre formation in open and deep lacustrine embayments: the example of Lake Geneva, Switzerland. *Environmental Fluid Mechanics*. doi:10.1007/s10652-016-9494-8.
- Schwefel, R., A. Gaudard, A. Wüest and D. Bouffard (2016). Effects of climate change on deepwater oxygen and winter mixing in a deep lake (Lake Geneva): Comparing observational findings and modeling. *Water Resources Research* **52**(11): 8811–8826, doi:10.1002/2016WR019194.
- Valipour, R., L. Boegman, D. Bouffard, Y.R. Rao (2016). Sediment resuspension mechanisms and their contributions to high-turbidity events in a large lake. *Limnology and Oceanography* doi: 10.1002/lno.10485.

### 8.2. Submitted manuscripts to peer-reviewed Journals in 2016

- Rahaghi A.I., Lemmin U., Bouffard D., Riffler M., Wunderle S., and D.A. Barry. 2016. Spatiotemporal distribution and variability of surface heat flux over a large European lake using satellite, meteorological patterns and in situ measurements. Submitted to JGLR
- Råman Vinnå, C.L.M., A. Wüest and D. Bouffard (submitted). Effects of thermal pollution on short-retention time inland waters - a study combining modeling and observations. *Water Resources Research*. Submitted
- Kiefer, I., A. Wüest, D. Odermatt, M. Riffler and D. Bouffard (submitted). Are surface temperature and chlorophyll in a large deep lake related? An analysis using satellite imagery. *Biogeochemistry submitted*
- Steinsberger, T. M. Schmid, A. Wüest, R. Schwefel, B. Wehrli and B. Müller (submitted). Organic carbon mass accumulation rate regulates the flux of reduced substances from lake sediments. submitted to *Environ. Sci. Technol.* ID: es-2016-033314
- Schwefel, R., M. Hondzo, A. Wüest, and D. Bouffard (submitted). Scaling oxygen microprofiles in natural waters. *Geophysical Research Letters*. Revised.
- Schwefel, R., T. Steinsberger, D. Bouffard, L. Bryant, B. Müller, and A. Wüest (submitted) Oxygen depletion in deep lakes: Using small-scale measurements to understand spatial variability of oxygen depletion in a large perialpine. To be submitted to *Limnology Oceanography* in 2016.

### 8.3. Reports and expert services in 2016

- Müller, B. und A. Wüest (2016). Abnahme des Phosphorgehalts im Zugersee - Stand 2016. Bericht für AfU Kt. Zug, Eawag Kastanienbaum, 28 p.
- Gaudard A. (2016). Wärme- und Kältenutzung aus Briener-, Thuner- und Bielersee. Abschätzung des Potentials und Beeinflussung der Seeökosysteme. AWA Kanton Bern. März 2016, Eawag Kastanienbaum, 27 p.
- Gaudard A. (2016). Wärme- und Kältenutzung aus Sempacher- und Baldeggersee. Umwelt und Energie (uwe) Kanton Luzern. Januar 2016, Eawag Kastanienbaum, 24 p.
- Wahl B., K. Zintz, G. Fink, M. Fleig, U. Lang, S. Mirbach, R. Schick, und, A. Wüest (2015). KlimBo – Klimawandel am Bodensee. Interreg IV-Forschungsprojekt von 2011 – 2015. Internationale Gewässerschutzkommission für den Bodensee (IGKB), Blaue Reihe Bericht 60. ISSN 1011-1263.
- Wüest A. und A. Gaudard (2015). Schwankungen der Temperaturen und Sauerstoffgehalte bei der Seewasserfassung zur Kühlung des CSCS, Lugano. Bericht an AquaPlus, Zug, März 2015, Eawag Kastanienbaum und EPFL Lausanne, 19 p.
- Wüest A., F.S. Anselmetti, N. Dubois, M. Hilbe, M. Strasser, M. Strupler (2016). Ergänzungen zur Machbarkeitsstudie „Sihlentlastung in den Zürichsee“, zuhanden AWEL Zürich, Eawag Kastanienbaum, Februar 2016, 73 p mit Anhängen.
- Wüest A., und L. Råman Vinnå, (2016). *Temperaturmessungen in der Zihl - Winter 2014 / 2015*. Bericht zuhanden Energieservice Biel (ESB), Eawag Kastanienbaum, Januar 2016, 9 p mit Anhängen.

## 9. TEACHING

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### 9.1. Courses

- **Limnology**, Master course, spring term 2016, ENV-425, Env. Engineering, EPFL.
- Modelling mixing and transport in lakes, harbors and estuaries. ICTP-University of Trieste, Italy. Winter short course, January 2016 (lecturer).

### 9.2. PhD Student supervised 2016

- Nouchi Vincent (ongoing); Remote sensing with ULM and APEX
- Robert Schwefel (ongoing); Oxygen depletion in Lake Geneva
- Love Råman Vinnå (ongoing); Optimizing water intake in Lake Biel
- Theo Baracchini (ongoing); Hydrodynamic modelling and assimilation of remote sensing data.
- Ulrike Kobler (ongoing); Effects of pump storage operation on lakes
- Oscar Sepúlveda Steiner (new since April 2016); Resolving horizontal structures in lakes.

### 9.3. PhD Student exams in 2016

- Gros J. (2016). Investigating the fate of petroleum fluids released in the marine environment with comprehensive two-dimensional gas chromatography and transport models. *PhD thesis EPFL nr 6883*. Internal expert (Examiner: S.J. Arey, Reddy, and S Socolofsky).
- Spahr S. (2016). Formation of N-nitrosodimethylamine during water disinfection with chloramine: Insights into reaction mechanisms from isotope fractionation analyses. *PhD thesis EPFL*. Examiner president (Examiner: U. von Gunten and TB. Hofstetter).

- Leresche F. (2016). Effects of dissolved organic matter on the phototransformation of aromatic amines in surface waters- *PhD thesis EPFL*. Examiner president (Examiner: U. von Gunten and Silvio Canonica).

#### 9.4. Master students in 2016

- Ratouis Perrine (February 2016). Spatial dynamics of surface thermal patterns in a shallow littoral zone using ground-based infrared imagery. Master thesis École Polytechnique Fédérale de Lausanne, EPFL (*Supervisors*: Prof. S. Geoffrey Schladow, Tahoe Environmental Research Center (TERC) – University of California).
- Gonzales Zurita, Fabrizio (July 2016). Coupled 3D hydrodynamic and water quality modelling of the eutrophic lake Greifensee. Master thesis École Polytechnique Fédérale de Lausanne, EPFL (*Supervisors*: Theo Baracchini and Dr Damien Bouffard).
- Etter Oriane (September 2016). Integrated approach of urban water system in lakes. Master thesis at École Polytechnique Fédérale de Lausanne, EPFL (*Supervisors*: Dr Damien Bouffard and Dr. Luca Rossi)
- Chappuis Christel (September 2016). Coupled 3D hydrodynamic and water quality modelling of the eutrophic lake Greifensee. Master thesis École Polytechnique Fédérale de Lausanne, EPFL (*Supervisors*: Theo Baracchini and Dr Damien Bouffard).

### 10. CURRENT EXPERT AND CONSULTING ACTIVITIES

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- Member of the Eawag Directorate
- Member of Scientific Board to the 6<sup>th</sup> Symposium on Stratified Flow, Sep 2016
- 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, methan 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)
- Ercoftac, special interest group SIG5 in *Environmental Fluid Mechanics*.

### 11. PROPOSALS

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#### New, pending

- Physical-biological modelling of Lemman. Frossard V. (UMR CARRTEL), Liautey E (UMR CARRTEL) and D. Bouffard (APHYS EPFL).
- Hydrodynamic and biogeochemical processes affecting benthic microbial communities (submitted Sept. 2016 to CNRS, EC2CO)
- **Oxygen depletion in a deep perialpine lake**, Grant 200020\_165517 period = 1.7.2016 to 31.12.2017 from *Swiss National Science Foundation* (146 kFr). Prolongation of former project.
- **CORESIM, CO**upling **RE**remote **S**ensing, **I**n situ and **M**odelling data for inland waters, Bouffard D. (EPFL), Odermatt D (Odermatt and Brockmann GmbH), Anneville O (UMR CARRTEL) and A. Wüest (EPFL), submitted August 2015 to ESA, started in 2016.

## Recent on-going funding

- **A Flexible Underwater Distributed Robotic System for High-Resolution Sensing of Aquatic Ecosystems**, Alcherio Martinoli (responsible), Alfred Wüest, Bastiaan Ibelings (Uni Geneva), CRSII2\_160726 (décision du 9 juillet 2015) *SINERGIA*, SNF, CHF 386'304.00 (Total amount = 1,675 kCHF), Grant CRSII2\_160726
- **Léman exploration LÉXPLORE**, Research Equipment / SNSF - R'Equip 2014, Alfred Wüest, Natacha Tofield-Pasche, Bastiaan Ibelings (Uni Geneva), Swiss National Science Foundation, , 680 KCHF. Grant 206021\_157779, period = 01.05. 2015 to 30.04.2016 (12 months); Split with Uni Geneva on 50%/50% basis.
- **Life under the ice in Lake Ladoga**; 109 kF; contribution from the Limnology Center (external sponsoring via FEEL Foundation); total 1300 kF; dossier number: 9660 Internal project : 531254 (01.12.2014 au 30.11.2017)
- **Swiss Earth Observation Network (SEON)**; Schaepman et al., January 2013 to December 2016
- **SOLVE project Satellite Observation of Lakes and Vegetation Environments**; Ivanov (EPFL), Bouffard (EPFL), Clenet (EPFL), Akthman (Gamaya, CH), funded by SSO (CH).
- **Model**, Modélisation couplée hydro-biologique du Léman; DAMBRINE E, O. ANNEVILLE (UMR CARRETEL) and D Bouffard (APHYS, EPFL), ongoing.
- **Kivu Monitoring project**, Hydrodynamic modelling of Lake Kivu (EDMC/LKMP, Rwanda); PI: Deltares, NL, DamienBouffard (EPFL), started in 2016.

## Recently finished

- **Oxygen depletion in a deep perialpine lake**, Grant 200021-146652; period = 06.2013 to 05.2016 from *Swiss National Science Foundation* (195 kFr). Internal number 513 340. This project has been prolonged by 1.5 years and will end December 2017.
- **Particle distribution and fluxes in Lake Biel (assessing drinking water intake)**. Grant from *ESB Biel* (276 kFr). End: November 2016.