

Annual Report 2015

October 2014 to December 2015

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Physics of Aquatic Systems Laboratory APHYS at EPFL & Eawag



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 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.

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 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. 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 velocity. In addition, sediment cores are taken to estimate the contribution of the upward directed flux of reduced substances to the oxygen depletion. Using ADCP current meter records, two numerical models are calibrated to determine the flow in the bottom boundary layers of Lake Geneva. Combining these results with *in-situ* measurement data, the oxygen depletion of deep-waters are estimated and compared to the CIPEL long-term oxygen profiles since the 1950s. In addition, a one-dimensional 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

2.2. Particles distribution in Lake Biel (ESB funded)

The City of Biel uses lake-water as part of the drinking water supply. In winter 2009/2010 extremely high particle concentrations forced the temporary shut-down of the Ipsach/Bienne drinking water treatment plant for the first time since ~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, Aquadop – 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. Lemman-Baikal Project (Limnology Center funded)

This project aims at developing new remote sensing techniques using a hyperspectral camera on the ULM and other low-flying platforms to characterise water quality of both Lakes Geneva and Baikal. Our group focuses on linking the optical properties collected by hyperspectral cameras to the biological, physical and geological attributes. This project will provide (i) optimized water quality algorithms for remote sensing in lakes, (ii) ultra-high spectral and spatial resolution mapping of photoactive substances and (iii) better understanding of the horizontal patterns of biophysical parameters. This sub-project is part of an interdisciplinary project coordinated by the Limnology Center and includes the exchange of Russian students. The project came to an end in Autumn 2015.

2.4. 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.

2.5. 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 or Lake Constance (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.

2.6. Double diffusion in Lake Kivu (SNF funded)

This project focused on the observational characterization of interfaces and mixed layers at small-scale resolution of mm to cm of the double diffusive layering in the water column of Lake Kivu (East-Africa). The goal is to estimate the vertical fluxes of heat, salt and dissolved gases. Therefore it was first necessary to determine the sensor responses by using a new *in-situ* approach that is based on variable profiling speeds. The observations (the latest in January/February 2015) lead to a correction of a commonly used flux parameterisation and this correction was confirmed in *Direct Numerical Simulations*, which correctly reproduced the interface thicknesses observed in Lake Kivu. Future research will focus on the lateral structure of double-diffusive staircases, such as in Powel Lake (British Columbia) and Lake Kivu. The project came to an end in May 2015, however, we still plan to publish additional results from the 2015 fieldwork.

2.7. 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 about 0.5 to 1m 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 and direct numerical simulations.

2.8. Lake Ladoga (Limnology Center funded)

This project focuses on the observational characterization of under ice convection. The study is part of an interdisciplinary research project - which includes eight partners – 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.

3. MAJOR ACQUIRED EQUIPMENT

We had the opportunity to complete our field instrumentation with the grants from the Kamprad Chair as well as the EPFL start-up fund. The two pictures below show two key i acquired in 2013, the aluminium research boat (left) and the oxygen microprofiler (right). The acquisitions in 2015 comprise:

3.1. Workhorse ADCP Sentinel WHS600

This Workhorse Sentinel acoustic Doppler current profiler WHS600 works at 600 kHz with 256MB memory and is rated for 500 m depth for *in-situ* profile measurements in natural waters. It comes with 400 m of MacArtney Cable Type 5071 and a Mooring Systems Frame Model FIL-WHS. It can work in the High Resolution Profiling Modes WHHiRes.

3.2. Acoustic Transponding Releaser 866-A

The two additional Teledyne BENTHOS releasers acquired allow anchoring moorings without surface buoys – this became urgent due to vandalism on Lake Biel.

3.3. PME 5000 SCAMP

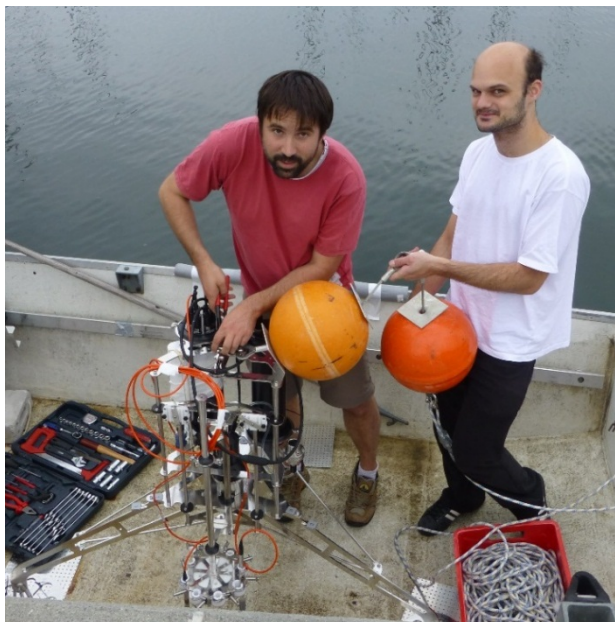
This self-contained autonomous microstructure profiler is designed for uprising measurements to depths of down to 100 m. The profiler setup is modular and can carry microsensors of temperature, salinity, fluorescence, and several other sensors.

3.4. RBR Thermistor chain

The RBR*concerto* logger supports up to 24 temperature nodes in any combination. Two self-contained autonomous thermistor chains (25 / 90 m lengths) will be deployed inline with the future platform on Lake Geneva. The two thermistor chains are intended to provide real-time high resolution temperature data at 0.25 to 1 m vertical resolution and temporal change in stratification.

3.5. Vaisala Meteostation AWS310, Data Collection and Processing System

The Vaisala AWS310 is a stand-alone weather data collection system which performs in all weather conditions and climates. It will update the actual Bouchillon mast (coordinate 520178 / 145756) for more accurate measurement. The QML201 base structure comes with two 30W dual solar panels.



3.6. Oxygen sensor miniDOT

The miniDOT, PME 7392, is an autonomous, completely submersible data logger for temperature and dissolved oxygen. The oxygen sensor is an optode that measures dissolved oxygen concentration in water by a fluorescence method. Data are recorded to an internal SD card. Operation of the miniDOT logger, such as setting the time and sample interval, can be accomplished via the USB cable.

3.7. Technicap Sàrl sediment trap P.P.S.4/3

The P.P.S.4/3 is a cylindro-conical sediment trap (collecting area: 0.05 m²) which works autonomously and is particularly adapted to high sedimentation regimes (lakes) and deployment from small research vessels. It can collect sequentially 12 consecutive samples of sediment particles into 12 bottles.

3.8. DMP SA LI-COR Quantum sensors & LI-1500G Light Sensor

The LI-COR Quantum sensors measure photosynthetically active radiation (PAR) in freshwater. The LI-1500G Light Sensor is a 3-sensor logger that can also display real-time data with GPS.

4. HUMAN RESOURCES (ALPH ORDER)

Theo Baracchini	PhD student since March 2015
Damien Bouffard	Scientist and supervisor of PhD students at EPFL, since November 2012
George Constantinescu	Visiting Professor, University of Iowa (USA), Department of, Civil and Environmental Engineering. from 1 June to 31 December 2015
Yasmin Dressler	Intern at APHYS (Eawag, KB); July and August 2015
Elisabeth Eder	PhD student until April 2015
Tania Gonin	Secretary of APHYS and LIMNC since November 2013

Isabel Kiefer	Master student, August 2014 to Nov 2015, scientific assistant until Nov 2015
Sébastien Lavanchy	Technician at APHYS (EPFL); since 15 May 2015
Benjamin Lemonier	Visiting Master student, <i>Université Pierre et Marie Curie (UPMC)</i> , Paris; 15 March - 15 August, 2015; as scientific assistant Sept. and Oct. 2015
Vincent Nouchi	PhD student since January 2014, project “ <i>ULM Leman-Baikal</i> ”
Daniel Odermatt	Scientist (10%) at Eawag, various projects on Remote Sensing
Michael Plüss	Technician at Eawag (80%); since 1 June 2015
Love Råman Vinnå	PhD student since July 2013, project “Particles in Lake Biel”
Perrine Ratouis	Master student, fall semester 2015 (UC Davis, Lake Tahoe)
Stephane Restani	Civilist at APHYS (EPFL); from Nov 2014 to April 2015
Gyan Rusconi-Rodrigues	Visiting Master student, University of California, Berkley, 1 May to 31 August 2015
Eliane Scharmin	Secretary of APHYS group at Eawag
Jonathan Schenk	Master student, spring semester 2015
Michael Schurter	Technician at Eawag; retired July 2015
Robert Schwefel	PhD student since January 2013, project “ <i>Oxygen depletion in Lake Geneva</i> ”
Tobias Sommer	PhD exam October 2013, Postdoc since May 2014 in project “ <i>Double diffusion in Lake Kivu</i> ”
Robert Uittenbogaard	Visiting Professor, DeltaRes, Delft Holland, from 1 March to 30 June 2015.
Alfred Wüest	Head of APHYS Eawag and APHYS EPFL (since Sep 2012).
Jessica Zanetti	Intern at APHYS (Eawag, KB); 1 June to 31 August 2015

Visitors in 2015

- **Lars Umlauf, and Peter Holterman**, Institut für Ostseeforschung, Warnemünde, Germany
- **Lee Bryant**, University of Bath, UK
- **George Constantinescu**, University of Iowa, USA.
- **Jaime Pitarch**, Postdoc at UCNRS Rome
- **Robert Uittenbogaard**, DeltaRes, Delft Holland
- **Elena Sanchez**, University of Granada
- **Stephen M. Henderson**, Washington State University, Vancouver (WA)

5. NETWORKING

5.1. Oxygen depletion in Lake Geneva

- Lars Umlauf, and Peter Holterman, Institut für Ostseeforschung, Warnemünde, Germany
- Lee Bryant, University of Bath, UK
- Beat Müller, Thomas Chwalek, Eawag
- George Constantinescu, University of Iowa, USA..

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. Lemman-Baikal Project

- Limnology Centre, EPFL
- Russian partners from Moscow State University, Metropol, and Ulan Ude University
- EPFL partners: TOPO, LASIG, WIRE, EFLUM, ECOL laboratories.

5.4. Remote sensing

- Yosef Akhtman and Bertrand Merminod, TOPO, EPFL, Lausanne
- Daniel Odermatt, Brockmann-Consult, Zürich
- SEON: Alexander Damm and Andreas Hueni; Geography Institute, U of Zürich
- Stefan Wunderle, University of Bern

5.5. Klimbo

- Thomas Wolf and Bernd Wahl, Institute for Lake Research, Langenargen, Germany
- Ulrich Lang, Kobus and Partner, Stuttgart, Germany.

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

Within the next four years, we envisage to initiate 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. A revised proposal was submitted by 15 January 2015 to FNS and was subsequently approved.

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.

6.3. Sentinel-3 validation team

The Sentinel 3A satellite is planned to be launched in December 2015 with high-resolution hyperspectral sensors (3B and 3C will be launched later). The APHYS team will take part as a validation team that will provide ground truthing for the validation of the satellite information. The platform (see above) will be equipped with specific optical sensors for this purpose.

6.4. Lake Ladoga project

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. In March 2015, the first fieldwork was performed on Lake Onega, as the ice-cover on Lake Ladoga was too weak.

6.5. Hydrodynamic modelling including data assimilation

The main goal of this research is to integrate all information (remote sensing data, field observation and numerical model) through data assimilation. The complimentary use of the information source will allow investigating new research topics such as the mesoscale processes (gyres, vortices etc...). A first part of the project is funded by an approved ESA grant. We hope to complete the financial support by another FNS proposal to be submitted in April 2016.

7. CONFERENCES IN 2014 AND 2015

2014

- Wulf H., Damm A., Segl K., Weyermann J., Morsdorf F., Wüest A., Naegeli K., Huss M., Joerg P., Schaepman M. 2014, *Simulated Sentinel-2 Products: Quantification and Validation of derived Essential Climate Variables*. Sentinel-2 for Science Workshop. Oral presentation Contribution ID: 146.
- Reusch A., Moernaut J., Loher M., Hilbe M., Meinecke G., Kipfer R., Anselmetti F., Bouffard D., and M. Strasser. 2014. *Subsurface sediment mobilization and active pockmarks from sublacustrine ground-water seepage*. AGU Fall Meeting. San Francisco, USA.
- Razmi A., Barry D.A., Bouffard D., and U. Lemmin. 2014. Typical near surface layer current patterns in Lake Geneva's main basin (Grand Lac). AGU Fall Meeting. San Francisco, USA.
- Loher M., Reusch A., Lilley M., Bouffard D., Bernasconi S.M., and M. Strasser. 2014. Pockmarks in Lake Neuchâtel: studying the sedimentological and geochemical characteristics of three crater-shaped lake floor depressions. ISC, Geneva, Switzerland.
- Schwalb A. N., Bouffard, D., Boegman L., Leon L., Winter J.G., Molot L. and R.E.H Smith. 2014. Hydrodynamic Controls on Dreissenid mussel energetics and Impacts: Insights from 3D modelling in Lake Simcoe. Conference IAGLR Hamilton, ON, Canada.
- Nakhaei N., Boegman, L. and D. Bouffard. 2014. Modelling sediment oxygen demand in stratified lakes. Conference IAGLR Hamilton, ON, Canada.
- Schwefel R. V., Bouffard D., Bryant L., and A. Wüest. 2014. Sediment oxygen uptake in Lake Geneva. 46th International Liege Colloquium, Low oxygen environments in marine, estuarine and fresh waters, Liège, Belgium.

- Bouffard D., Schwefel R., Wüest A., Holtermann P. and L. Umlauf. 2014. Process based modelling of Lake Geneva. OS Honolulu, USA.
- Bouffard, D., Schwefel, R., Gaudard, A., Lemmin, U., Wüest, A.: *Process-based modelling of Lake Geneva*, 17th International Workshop on Physical Processes in Natural Waters, Trento, Italy, July 1-4, 2014.
- Schwefel, R., Bouffard, D., Bryant, L., Wüest, A: Sediment Oxygen Uptake in Lake Geneva, 46th International Liege colloquium, Low oxygen environments in marine, estuarine and fresh waters, Liège, Belgium, May 5-9, 2014. Poster Presentation.
- Schwefel, R., Bouffard, D., Wüest, A: Impact of deep-water mixing on hypoxia in Lake Geneva, 2015 Aquatic Sciences Meeting, Granada, Spain, February 22-27, 2015. Oral Presentation.
- Råman Vinnå, L., Bouffard, D., A method for using ADCP echo intensity to track particle movements in Lake Biel. International Symposium on Ultrasonic Doppler Methods for Fluid Mechanics and Fluid Engineering, Strasbourg, France, 27 – 29 August, 2014. Oral Presentation.

2015

- Bouffard, D., I. Kiefer, J. Selander, A. Wüest, 6 July 2016. Physical processes controlling spatial variability of chlorophyll-a in the large Lake Geneva. Tralk, SEFS 2015, University of Geneva.
- Cubero-Castan, M. S. P., D. Constantin, K. S. Barbieux, V. M. Nouchi and Y. Akhtman et al. A new smoothness based strategy for semi-supervised atmospheric correction: application to the Léman-Baïkal campaign. 7th Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing, Tokyo, Japan, 2015.
- Fink G. und A. Wüest, 21 Januar 2015, *Klimatische Veränderungen im Einzugsgebiet: Effekte auf den Bodensee*. Talk, Klimbo-Projekt Abschlussveranstaltung, Frasnacht Thurau.
- Kauer, Tuuli; Kutser, Tiit; Danckaert, Thomas; Arst, Helgi, Nõges, Tiina; Alfred Wüest, *Modelling primary productivity time series with simple bio-optical model in some large European lakes*. Talk, Oral presentation, Sentinel-3 for Science Workshop.
- Raghghi, A.I., U. Lemmin, D. Bouffard, M. Rifler, S. Wunderle. 6 July 2016. Talk 00623 - Surface thermal patterns of Lake Geneva from 2008 to 2012. SEFS 2015, University of Geneva.
- Råman Vinnå, L. 6 March 2015, *The effect of anthropogenic heat emission in a short retention time Lake system*. Talk, Bodenseephysiker Treffen Konstanz.
- Schmid, M., C. Tsimriti, N. Budnev, M. Schurter, M. Sturm, and A. Wüest, 6 July 2016, *What can we learn from 13 years of temperature observations in the South Basin of Lake Baikal?* Talk, SEFS 2015, University of Geneva
- Schwefel, R., Bouffard, D., Wüest, A: February 22-27, 2015, *Impact of deepwater mixing on hypoxia in Lake Geneva, 2015*. Aquatic Sciences Meeting, Granada, Spain, Talk. Oral Presentation.
- Sommer T., 28 August 2015, *Bacteria cause mixing in Lago di Cadagno, Switzerland*. Talk, Workshop: Physical Processes in Natural Waters (PPNW) in Landau, Germany.
- Tarasov, M., G. Shinkareva, O. Tutubalina, M. Lychagin and D. Constantin et al. *Investigation of heavy metals distribution in suspended matter and macrophytes of the Selenga river delta using airborne hyperspectral remote sensing*. 9th EARSeL SIG Imaging Spectroscopy workshop, LIST, Luxembourg, 2015.
- Vincent Nouchi, Daniel Odermatt, Damien Bouffard, Natacha Tofield-Pasche, Alfred Wüest, 6 July 2016, *Water quality retrieval using hyperspectral observations by ultralight aircrafts over the Selenga Delta in Lake Baikal*. Talk, SEF 2015, University of Geneva.

Wüest A. und G. Fink, 21 Januar 2015, *Wärmenutzung am Bodensee – wieviel wäre zuviel?* Talk, Klimbo-Projekt Abschlussveranstaltung, Frasnacht Thurau.

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, Talk, University Basel.

Wüest, A., Tobias Sommer, Jeffrey R. Carpenter and Marco 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), Oaxaca, Mexico.

8. PUBLICATIONS IN 2014 AND 2015

8.1. Published peer-reviewed papers in 2014

Akhtman Y., Constantin D., Rehak M., Nouchi V.M., Shinkareva G., Bouffard D., Pasche N., Chalov S., Lemmin U., and B. Merminod. Télédétection multi-échelle des lacs depuis un aéronef ultra léger motorisé. *Géomatique Suisse*, 9, 2014.

Bouffard, D., Boegman, L., Ackerman, J. D., Valipour, R., & Rao, Y. R. (2014). Near-inertial wave driven dissolved oxygen transfer through the thermocline of a large lake. *Journal of Great Lakes Research*, 40(2), 300-307.

Fink G., M. Schmid, B. Wahl, T. Wolf and A. Wüest (2014a). Heat flux modifications related to climate-induced warming of large European lakes. *Water Resources Research*. 50, 2072 – 2085, doi: 10.1002/2013WR014448.

Fink, G., M. Schmid and A. Wüest (2014b). Large lakes as sources and sinks of anthropogenic heat: Capacities and limits. *Water Resources Research*. 50: 7285–7301, doi:10.1002/2014WR015509.

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Muvundja F.A., A. Wüest, M. Isumbisho, M. B. Kaningini, N. Pasche, P. Rinta and M. Schmid (2014). Modelling Lake Kivu water level variations over the last seven decades. *Limnologica – Ecology and Management of Inland Waters*, 47: 21-33, doi:10.1016/j.limno.2014.02.003.

Paturi, S., Boegman, L., Bouffard, D., and Rao, R.Y. (2014). "Three-Dimensional Simulation of Lake Ontario North-Shore Hydrodynamics and Contaminant Transport." *J. Hydraul. Eng.*, 04014082: 04014082-1 to 04014082-16. doi:10.1061/(ASCE)HY.1943-7900.0000963.

Pitarch J., D. Odermatt, M. Kawka, and A. Wüest (2014). Retrieval of vertical particle concentration profiles by optical remote sensing: a model study. *Optics Express*, 22(S3): A947 - A959, doi: 10.1364/OE.22.00A947.

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- Scheifele B., R. Pawlowicz, T. Sommer, and A. Wüest (2014). Double diffusion in saline Powell Lake, British Columbia. *Journal of Physical Oceanography*, **44**(11): doi:10.1175/JPO-D-14-0070.1.
- Schmid M., S. Hunziker, and A. Wüest (2014). Lake surface temperatures in a changing climate: a global sensitivity analysis. *Climatic Change*. **124**(1-2): 301-315 doi:10.1007/s10584-014-1087-2.
- Sommer, T., J.R. Carpenter, and A. Wüest (2014). Double-diffusive interfaces in Lake Kivu reproduced by direct numerical simulations. *Geophysical Research Letters*, **41**: 5114–5121, doi: 10.1002/2014GL060716.
- Toffolon M., S. Piccolroaz, B. Majone, A-M. Soja, F. Peeters, M. Schmid and A. Wüest (2014). Prediction of surface temperature in lakes with different morphology using air temperature. *Limnology and Oceanography* **59**(6): 2185–2202. doi: 10.4319/lo.2014.59.6.0000.
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- Wüest A, Anselmetti FS, Arey JS, Ibelings BW, Loizeau JL, Vennemann T, Lemmin U (2014). Into the abyss of Lake Geneva: the elemo interdisciplinary field investigation using the MIR submersibles. *Aquatic Sciences* **76**(Suppl 1): S1-S6. doi: 10.1007/s00027-014-0353-8.

8.2. Published peer-reviewed papers in 2015

- Berg P., D.J. Koopmans M. Huettel H. Li, K. Mori, A. Wüest (2016). A new robust oxygen-temperature sensor for aquatic eddy covariance measurements. *Limnology and Oceanography – Methods*. LOM-15-04-0033.
- Kiefer, I, D. Odermatt, O. Anneville; A. Wüest, D. Bouffard (2015). Application of remote sensing for the optimization of in-situ sampling for monitoring of phytoplankton abundance in a large lake. *Science of the Total Environment*. 527–528: 493–506. doi: 10.1016/j.scitotenv.2015.05.011.
- Reusch, A., M. Loher, D. Bouffard, J. Moernaut, F. Hellmich, F.S. Anselmetti, S.M. Bernasconi, M. Hilbe, A. Kopf, M.D. Lilley, G. Meinecke and M. Strasser (2015). Giant lacustrine pockmarks with subaqueous groundwater discharge and subsurface sediment mobilization. *Geophys. Res. Lett.*, **42**: 3465–3473, doi:10.1002/2015GL064179.
- Ross K.A., E. Gashugi, A. Gafasi, A. Wüest, and M. Schmid (2015). Characterisation of the subaquatic groundwater discharge that maintains the permanent stratification within Lake Kivu; East-Africa. *PLoS ONE* **10**(3): e0121217. doi:10.1371/journal.pone.0121217.
- Schwalb, A.N., D Bouffard, L Boegman, L Leon, JG Winter, LA Molot, and R.E.H Smith (2015). 3D modelling of dreissenid mussel impacts on phytoplankton in a large lake supports the nearshore shunt hypothesis and the importance of wind-driven hydrodynamics. *Aquatic Sciences* **77**(1), 95-114.
- Stigebrandt, A., R. Rosenberg, L. Råman Vinnå and M. Ödalen. (2015). Consequences of artificial deepwater ventilation in the Bornholm Basin for oxygen conditions, cod reproduction and benthic biomass – a model study. *Ocean Science*, **11**: 93–110, doi:10.5194/os-11-93-2015
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- Tsimitri C., B. Rockel, A. Wüest, N. M. Budnev, M. Sturm, and M. Schmid (2015). Drivers of deep water renewal events observed over 13 years in the South Basin of Lake Baikal, *Journal of Geophysical Research - Oceans* **120**(3): 1508–1526, doi: 10.1002/2014JC010449.
- Valipour, R., D. Bouffard, L. Boegman, and Y.R. Rao (2015). Near-inertial waves in Lake Erie. *Limnology and Oceanography*, **60**(5): 1522–1535; doi: 10.1002/lno.10114

Valipour, R., D. Bouffard, and L. Boegman (2015). Parameterization of bottom mixed layer and logarithmic layer heights in central Lake Erie. *Journal of Great Lakes Research* **41**(3): 707-718.

8.3. Submitted manuscripts to peer-reviewed Journals in 2015

Bouffard D., R.E. Zdrovennov, G.E. Zdrovennova, N. Pasche, A. Wüest and A.Y. Terzhevik (2016). Ice covered lakes – Effects of solar radiation on convective plumes and internal waves. *Journal of Hydrobiologia*. Submitted.

Schwefel, R., D. Bouffard, A. Gaudard, and A. Wüest (submitted). Effects of climate change on deep-water oxygen and winter mixing in a deep lake (Lake Geneva) – Comparing observational findings and modeling. *Water Resources Research*. Submitted.

8.4. Reports and experts services in 2014 and 2015

2014

Gaudard A., D. Bouffard and A. Wüest (2014). Alternatives for the development of the EPFL water intake in Lake Geneva. Report APHYS-14-1 pour EPFL

Fink G., M. Wessels und A. Wüest (2014). Einfluss auf den Bodensee durch klimatische und hydrologische Entwicklungen im Einzugsgebiet. Partikeltransport in den Bodensee. KlimBo Teilprojekt 1a, 1b und 1d. Landesanstalt für Umwelt, Messungen und Naturschutz (LUBW). 18 August 2014

Wüest A. und G. Fink (2014). Potential zur Wärme- und Kühlenergienutzung aus dem Vierwaldstättersee – Machbarkeit. Aufsichtskommission Vierwaldstättersee (AKV), und Umwelt und Energie (Uwe), Kanton Luzern, Dezember 2014, Eawag Kastanienbaum, 29 p

Wüest A, G. Fink und H. Ehmann (2014). Empfehlungen für eine nachhaltige Wärmenutzung am Bodensee. Richtlinien. KlimBo Teilprojekt 4.h, 4p und Anhänge, Landesanstalt für Umwelt, Messungen und Naturschutz. November 2014

Wüest A, G. Fink und U. Lang (2014). Anwendung eines dreidimensionalen Modells und Verifikation des Wärmehaushaltsmodells für Auswirkungen von Wärmenutzungen. KlimBo Teilprojekt 4.f, 16p, Landesanstalt für Umwelt, Messungen und Naturschutz.. Mai 2014.

2015

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.

9. TEACHING

9.1. Courses

- **Limnology**, Master course, spring term 2015, ENV-425, Env. Engineering, EPFL
- **Environmental Fluid Mechanics – Lakes and Reservoirs**. University Joseph Fourier, LEGI, Grenoble, France, December 2014 (lecturer, A. Wüest)
- **Mixing and dispersion in flows dominated by rotation and buoyancy**. CISM, Udine, Italy, July 2015 (lecturer D. Bouffard)
- 50 ans d'assainissement des eaux usées autour de nos lacs: bilan, enjeux et perspectives, **VSA**, Lausanne, June 2015 (lecturer D. Bouffard)
- GEP, REP und Gewässerökologie, **VSA**, Nottwil, Oct 2014 (lecturer D. Bouffard).

9.2. PhD Student supervised 2013

- Nouchi Vincent (ongoing); Remote sensing with ULM and APEX
- Robert Schwefel (ongoing); Oxygen depletion in Lake Geneva
- Love Raman Vinnå (ongoing); Optimizing water intakes in Lake Biel
- Theo Baracchini (new since March 2015); Hydrodynamic modelling and assimilation of remote sensing data.
- Ulrike Kobler (new since January 2015); Effects of pump storage operation on lakes.

9.3. PhD Student exams in 2014 and 2015

- Cortes Cortes A. (2014) Splitting gravity currents in stratified systems. *PhD thesis Universidad de Granada*. Examiner president (*Supervisor*: F.J. Rueda Valdivia, *Experts*: E. Sanchez; R. Marcé, G. Vidal)
- Hoyer A. B. (2014) The physical control of contaminant distribution in aquatic ecosystems. *PhD thesis Universidad de Granada*. Examiner president (*Supervisor*: F.J. Rueda Valdivia, *Experts*: E. Sanchez; R. Marcé, G. Vidal)
- Thiébaud R. (2014). Résistance au déversement des poutres métalliques de ponts. Examiner president (*Supervisor*: J.P Lebet; *Experts*: M. Knobloch, D. Laurence and R. Antonio).
- Zheng N (2014) A Dynamic Network Approach for Multimodal Urban Mobility: Modeling, Pricing and Control. *PhD thesis EPFL*. Examiner president (Examiner: N. Geroliminis and M. Bierlaire).
- JAFARNEJAD CHAGHOOSHI M (2015). Time-dependent failure analysis of large block size riprap as bank protection in mountain rivers. *PhD thesis EPFL*. Examiner president (Examiner: A. Schleiss; E. Brühwiler, Martin Vide, Cardoso, Rickenmann).

9.4. Master students in 2015

- Schenk, J. (June 2015). Numerical modelling of lakes: 3D model validations and 1D model applications to Lake Morat. Master thesis EPFL Lausanne (*Supervisors*: Love Raman and Damien Bouffard).
- Lemonnier B. (June 2015). Modelling vertical distribution of *Planktothrix rubescens* in Lake Hallwil (Switzerland). Master thesis Université Pierre et Marie Curie, Paris and EPFL Lausanne (*Supervisors*: Damien Bouffard, Robert E. Uittenbogaard, Robert Schwefel).
- Ratouis, P (January 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).

10. CURRENT EXPERT AND CONSULTING ACTIVITIES

- Member of the Eawag Directorate
- Member of Scientific Board to the 6th 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
- 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

New, pending

- SNF, Oxygen depletion in Lake Geneva, PhD Robert Schwefel (submitted for prolongation)
- Frossard V. (UMR CARRETEL), Liautey E (UMR CARRETEL) and D. Bouffard (APHYS EPFL): Hydrodynamic and biogeochemical processes affecting benthic microbial communities (submitted August 2015 to CNRS, EC2CO)
- Bouffard D. (EPFL), Odermatt D (Odermatt and Brockmann Gmbh), Anneville O (UMR CARRETEL) and A. Wüest (EPFL): Coupling Remote sensing, In situ and modelling data for inland waters, submitted August 2015 to ESA, accepted
- Genseberger (Deltares, NL), Bouffard (EPFL, CH), Wüest (EPFL, CH), Porte Agel (EPFL, CH), Toffolon (Uni Trento, IT), Lemarie (INRIA, FR), Krause (USI, CH), Donners (SurfSara, NL), De Vries (KNMI, NL). Coupled hydrodynamic atmospheric lake modelling (submitted to H2020 Sept 2015).
- DeltaRes, EPFL, Eawag (2015). Hydrodynamic modelling of Lake Kivu, accepted.

Recent on-going funding

- Alcherio Martinoli (responsible), Alfred Wüest, Bastiaan Ibelings (Uni Geneva), "A Flexible Underwater Distributed Robotic System for High-Resolution Sensing of Aquatic Ecosystems". CRSII2_160726 (décision du 9 juillet 2015) *SINERGIA*, SNF, CHF 386'304.00 (Total amount = 1,675 kCHF), Grant CRSII2_160726
- Alfred Wüest, Natacha Tofield-Pasche, Bastiaan Ibelings (Uni Geneva), Swiss National Science Foundation, Research Equipment / SNSF - R'Equip 2014, Léman exploration (LÉXPLORE), 680 KCHF. Grant 206021_157779, period = 01.05. 2015 to 30.04.2016 (12 months); Split with Uni Geneva on 50%/50% basis.
- Swiss Earth Observation Network (SEON), Schaepman et al., January 2013 to December 2016
- Ivanov (EPFL), Bouffard (EPFL), Clenet (EPFL), Akthman (Gamaya, CH), SOLVE project Satellite Observation of Lakes and Vegetation Environments, (Funded by SSO, CH).
- DAMBRINE E, O. ANNEVILLE (UMR CARRETEL) and D Bouffard (APHYS, EPFL): Modélisation couplée hydro-biologique du Léman, Model (ongoing).

Recently finished

- Ccem, particle budgets in hydropower plants, March 2015 (finished)
- Lake Kivu - turbulence and double diffusion in permanent stratification, 01.05.2013 to 30.04.2015, Swiss National Science Foundation 200020_140538 (finished).