



The mission of the LIMNOLOGY Center is to provide socially-relevant and multi-disciplinary research to ensure the sustainable use and conservation of natural water resources, both on national and international levels.

LIMNOLOGY Center EPFL ENT LIMNC Station 2 CH-1015 Lausanne Switzerland Phone: +41 693 59 43 http://limnc.epfl.ch alfred.wueest@epfl.ch natacha.tofield-pasche@epfl.ch



Annual report 2017

# **LIMNOLOGY Center** Ecole Polytechnique Fédérale de Lausanne

### **EDITORIAL**

Also in 2017 we had many colorful experiences with fieldwork, LéXPLORE planning and publications:

In March and June 2017, scientists from EPFL, UniGe, Eawag, INRA-Thonon and the Observatory Midi-Pyrénées gather together with the Russian colleagues for the last time in Petrozavodsk for fieldwork on Lake Onego. Therewith ended a three years-long successful and productive collaboration. We decided (i) to prepare for joint publications in a special issue in "Inland Waters" for the year 2019, (ii) to prepare for contributions to ELLS-IAGLR conference "Big Lakes – Small World" in Evian planned for September 2018, and (iii) to organize in parallel a closing ceremony for the "Life under Ice" project together with our Russian colleagues. We were extremely lucky, that the first joint conference of this kind was foreseen on Lake Geneva. with the perspective to bring our Russian and North-American colleagues together. It is still today surprising, how little is known of the two large lakes in Karelia.

The rest of the year 2017 was devoted to the planning of the LéXPLORE platform. A highlight for us was the great financial support we received from EPFL, Eawag, UniGE and UniL in the form of 950 kCHF for the buildup of the physical structure, which we hope will arrive beginning 2019. The groups from EPFL and UniL have already submitted proposals to SNF to initiate research on the platform related to the primary productivity and carbon budget of Lake Geneva.

We could welcome a new face in the Center: Adem Topak as a technical assistant from September 2017.

We warmly thank the researchers, the support personnel and the sponsors for this encouraging work in Karelia and for the LéXPLORE Platform. THANK YOU ALL.

Alfred Wüest, Director LIMNOLOGY Center



Boat La Seiche used for fieldwork in Switzerland

## **R**ESEARCH PROJECT: LIFE UNDER ICE

2017 has officially been the last year for the *Ladoga: life under ice* project, a Swiss-Russian collaboration where about 40 scientists from different fields join together to investigate physics, chemistry and biology of the two large ice-covered lakes Ladoga and Onego in Russia. Two final sampling campaigns were conducted in 2017, to study the ice-cover period and the spring season after ice melt. Lake Ladoga, however, remained ice-free this winter, comparable to previous years, so our investigations continued to focus on Lake Onego.



Ice-free Lake Ladoga (left) and frozen Lake Onego in March 2017

Scientists at the Ice Camp station on Lake Onego in March 2017

#### FIELD CAMPAIGN MARCH 2017

Our previous campaigns on Lake Onego had shown that light penetration through the ice can form a cm to dm thick boundary layer directly under the ice-cover. The dynamics of this under-ice boundary layer and its biological relevance as a hot spot for life under ice were investigated together by physicists and biologists in a joint project. Phytoplankton growth was studied in an "illumination experiment", where small light bulbs were added to bottles filled with lake water. For zooplankton, a new, horizontal, sampling strategy was developed to sample these little animals from within the boundary layer.



In-situ light-experiment to study phytoplankton growth under ice

Horizontal sampling under ice for zooplankton

## **R**ESEARCH PROJECT: LIFE UNDER ICE

#### **FIELD CAMPAIGN JUNE 2016**

The spring campaign on Lake Onego was conducted from the Russian research vessel *EKOLOG*, and dedicated to resolve spatial and temporal variations in phytoplankton, water chemistry, and carbon dioxide ( $CO_2$ ). For the first time, floating chambers with  $CO_2$  sensors were deployed on the lake surface to directly measure the exchange of  $CO_2$  between lake and atmosphere. These measurements showed that the lake acts as both source and sink of this greenhouse gas, depending on location and timing of the day.





The spring crew in front of the *EKOLOG* research vessel

 $\label{eq:measuring CO_2} \mbox{ emissions on Lake Onego} \\ \mbox{ with floating chambers} \\$ 

Also, for the first time, the thermal bar could be well resolved in Lake Onego over the cruise. The thermal bar is a special phenomenon occurring during spring, when the lake progressively warms up from shallow areas towards the open lake. Where water temperatures hit 4°C, a thermal "barrier" is formed because water reaches its highest density. This barrier has further implications for the distribution of chemical compounds and planktonic life.



Temperature section through Lake Onego. The thermal bar is located at the vertical 4°C line, as indicated in red.

We would like to warmly thank our sponsors:



#### and coordination:



Consulat honoraire de la Fédération de Russie à Lausanne

# **R**ESEARCH PROJECT:

### Meromictic lakes in British Columbia, Canada

Last year, we investigated twelve lakes in British Columbia, to search for unusual lakes containing very old seawater at depth. These special lakes were former fjords cut off from the ocean after the isostatic rebound from the last glaciation. Due to the deep layer of denser seawater, these lakes are meromictic, which means that they never mix their entire water column.





Investigating lakes in Canada by hydroplane

View on lakes from the hydroplane.

Out of twelve investigated lakes during September 2016, three showed water column profiles that indicated meromictic conditions by their high conductivities, relative warm temperatures, and oxygen-free conditions in deep water layers. The analysis of water samples from these lakes furthermore showed an immense accumulation of nutrients, organic carbon, as well as carbon dioxide and methane in the deep. The age of the deep organic material was measured by radiocarbon dating, and showed ages up to 1290 years in these meromictic lakes. For comparison, in normal freshwater lakes, organic material in the deep was much younger with ages between 25 and 621 years.



By now, all samples have been analyzed and show results that are promising for more important multidisciplinary project led by the Limnology Center at EPFL in collaboration with local partners in BC Canada.

Vertical profiles of temperature, conductivity and oxygen in Hesquiat Lake

## HUMAN RESOURCES WITHIN THE CENTER:

**Sebastien Lavanchy** became the project manager from LéXPLORE platform during Natacha Tofield-Pasche's maternity leave. He also participated in all the field campaigns from the Limnology Center to support scientists and to prepare their equipment. The center thanks him for his precious help.



AdemTopak,joinedtheLimnologyCenterfromSeptember 2017 to mi-May 2018.He was a great help during fieldcampaigns, instrumentation, andpreparation of sediment samples.We are glad to welcome him inour team.

Hannah Chmiel successfully organized the two field campaigns on Lake Onego in collaboration with our colleagues from the Northern Water Problems Institute. We thanks her for a great job.



# HUMAN RESOURCES: LIFE UNDER ICE

#### In Russia:

#### Northern Water Problems Institute, KRC RAS, Petrozavodsk:

*Physic group:* Dr. Arkady Terzhevik, Dr. Roman Zdorovennov, Dr. Galina Zdorovennova, Sergei Bodganov

*Biological group:* Dr. Natalja Kalinkina, Chekryzheva Tatjana, Tekanova Elena, Syarki Maria, Georgiev Andrei.

*Chemical group:* Dr. Petr Lozovic, Rodkina I.S., Efremova T.A., Ptitca A.I, Stepanova I.A., Zobkova M.V., Basova S.V., Efremenko N.A., Dmitrieva Yu.F., Zobkov M.B., Galakhina N.E., Kalmykov M.V., Ikko O.I.

*Hydrology-climate* group: Prof. Nikolay Filatov, Larisa Nazarova, Nikolai Palshin, Tatjana Efremova, Andrey Balagansky, Vasili Kovalenko, Sergei Volkov

Sediment group: Dr. Dmitry Subetto, Dr. Natalia Belkina, Makarova Elena, Liudmila S. Syrykh

Limnological Institute St-Petersburg: Anna V. Ludikova

Arctic and Antarctic Research Institute: Dr. Boris Ivanov

Nansen International Environments and Remote Sensing Center: Dr. Anton Korosov and Vladimir Volkov.

#### In France:

**UMR CARRTEL, INRA-Thonon-les-Bains:** Dr. Emilie Lyautey, Dr. Marie-Elodie Perga, Dr. Victor Frossard, and Dr. Thomas Camille

OMP-LEGOS: Dr. Alexei V. Kouraev.

#### In Switzerland:

**University of Geneva:** Prof. Daniel Ariztegui, Prof. Bastiaan W. Ibelings, Marie-Caroline Tiffay, Ena Suarez Bolanos, Dr. Patrick Venail, Prof. Vera Slaveykova, Dr. Isabelle Worms, Mariapaola Avellino, and Teofana Chonova

**Eawag:** Dr. Nathalie Dubois, Mischa Haas, Alois Zwyssig, Dr. Beat Müller, Dr. Carsten Schubert, and Michael Plüss

University of Constance: Dr. Hilmar Hofmann

#### Within EPFL:

**APHYS-Margaretha Kamprad Chair:** Dr. Damien Bouffard, Love Raman, Sebastien Lavanchy, Dr. Natacha Pasche, Dr. Hannah Chmiel and Prof. Alfred Wüest

DISAL: Dr. Felix Schill, Dr. Alexander Bahr, and Prof. Alcherio Martinoli

**TOPO:** Kevin Barbieux, Sergei Smirnov, Aleksandrs Trufanovs, and Prof. Bertrand Merminod



Group working on Lake Onego sediment in March 2016

# **SCIENTIFIC PUBLICATIONS**

Kouraev A.V., Zakharova E.A., Naumenko M.A., Shimaraev M.N., Kostianoy A.G., Hall N.M.J., Suknev A.Y., Remy F. (2016) **Ice regime of Eurasian lakes and internal seas**. Proceedings of the XVI Glaciological Symposium «Past, present, and future of the Earth cryosphere», 24-29 May 2016, St. Petersbourg, Russia.

Kouraev A.V., Zakharova E.A, Naumenko M.N., Shimaraev M.N., Kostianoy A.G., Suknev A.Ya, Filatov N.N., Remy F. (2016) **Ice cover of Eurasian water bodies in a changing climate from satellite and in situ observations**. Proceedings of the ESA Living Planet Symposium, Prague, Czech Republic, 9-13 May 2016

Palshin N.I. and Efremova T.V. (2017) **Thermal structure of the lakes of the North-West of Russia during the freeze-up period**. Geography and Natural Resources. 38(2): 147-153. DOI: 10.1134/S1875372817020056

Filatov N.N. (2017). Whether a law on the protection of Ladoga and Onega lakes? Water Magazine. 7 (119):36-41. July 2017 (In Russian with English summary).

Bouffard D., Ulloa H. N., Zdorovennov R., Zdorovennova G., Volkov S., Bogdanov S., Terzhevik A., Wüest A. (2017). **Boundary layer under an ice-covered lake**. Proceedings of 20<sup>th</sup> Workshop on Physical Processes in Natural Waters, Hyytiälä, Finland, 21-25 August 2017, p. 15-17

Kouraev A.V., Zakharova E., Filatov N.N., Baklagin S., Barbieux K., Merminod B., Pozdnyakov D.V., Kondrik D.A. (2017) **Multiscale multispectral remote sensing of ice cover in lakes Onego and Ladoga using a combination of spaceborne, aerial drone and ground-based measurements.** Proceedings of the 1<sup>st</sup> International Conference "Lakes of Eurasia: Problems and solutions", 11–15 September 2017, Petrozavodsk, Russia

Efremova T.V., Palshin N.I. (2017) **Ice phenology and thermal structure lakes of North-Western Russia during the ice cover period (long-term observational data).** Proceedings of the 1<sup>st</sup> International Conference "Lakes of Eurasia: Problems and solutions", 11–15 September 2017, Petrozavodsk, Russia

Zdorovennov R.E., Mitrokhov A.V., Palshin N.I., Volkov S.Yu., Terzhevik A.Y (2017) **Methods for conducting hydrophysical measurements in ice-covered lakes.** Proceedings of the 1<sup>st</sup> International Conference "Lakes of Eurasia: Problems and solutions", 11–15 September 2017, Petrozavodsk, Russia

Menshutkin V. and Filatov N. (2017) **Models of Lake Ladoga based on threedimensional cellular automata**. Proceedings of the Karelian Research Centre of the Russian Academy of Sciences. 93. 10.17076/lim582. (In Russian with English summary).

Сярки М.Т., Фомина Ю.Ю. Зоопланктон Петрозаводской губы Онежского озера в подледный период // Ученые записки Петрозаводского государственного университета. № 6 (167). 2017. С.90-95. [Syarki M., Fomina Y. **Zooplankton of Petrozavodskaya Bay of Onego Lake in under-ice period** // Proceedings of Petrozavodsk state University. 2017. Vol. 6(167). Р. 90-95.

Filatov N., Diansky N., Golosov S., Ibraev R., Viriuchalkina T., Zverev I. (2017) The integrated study of the current state of the hydrological regime and water ecosystems of Russia's largest (great) lakes. Proceedings of the 3<sup>rd</sup> Pan-Eurasian Experiment (PEEX) Conference and the 7<sup>th</sup> PEEX Meeting. Helsinki, Report Series. www.atm.helsinki.fi/FAAR/ in Aerosol Science 201:116-117.

## CONFERENCES

### Life under ice project:

European Geosciences Union, General Assembly, Vienna, April 2017 Thomas C., Perga M.-E., Frossard V., Pasche N., Hofmann H., Ariztegui D., Dubois N., Belkina N., Lyautey E. **Vertical structure and horizontal variations in the cycling of methane in the sediment of Lake Onego, Russia**. In *EGU General Assembly Conference Abstracts 19, 12408, Vienna, Austria* (Poster)

PAGES 5<sup>th</sup> Open Science Meeting, Zaragoza, Spain, May 2017 Haas M., Belkina N., Subetto D., Dubois N. **How politics shape agricultural landscapes: The plant wax record of Lake Lavijärvi, Russia Karelia**. (poster)

Physical Processes in Natural Waters, Helsinki, Finland, August 2017 Bouffard D., Zdorovennov R., Zdorovennova G., Terzhevik A., Wüest A. (2017). **Under** ice convective processes in lake.

1st International Conference "Lakes of Eurasia: Problems and solutions", 11–15 September 2017, Petrozavodsk, Russia:

- Efremova T.V., Palshin N.I. Ice phenology and thermal structure lakes of North-Western Russia during the ice cover period (long-term observational data).
- Filatov N.N. Current problems of forecasting hydrological regime and changes of ecosystem lake of Eurasia
- Kouraev A.V., Zakharova E., Filatov N.N., Baklagin S., Barbieux K., Merminod B., Pozdnyakov D.V., Kondrik D.A. Multiscale multispectral remote sensing of ice cover in lakes Onego and Ladoga using a combination of spaceborne, aerial drone and ground-based measurements.
- Zdorovennov R.E., Mitrokhov A.V., Palshin N.I., Volkov S.Y., Terzhevik A.Y. Methods for conducting hydrophysical measurements in ice-covered lakes.

Swiss Geoscience Meeting, Davos, Switzerland, November 2017 Haas M., Belkina N., Subetto D., Dubois N. **How politics shape agricultural landscapes: The plant wax record of Lake Lavijärvi, Russia Karelia**. (poster)

3<sup>rd</sup> Pan-Eurasian Experiment Conference and the 7<sup>th</sup> PEEX Meeting, Helsinki, 2017 Filatov N. **The integrated study of the current state of the hydrological regime and** water ecosystems of Russia's largest (great) lakes

### Leman-Baikal project:

European Geosciences Union, General Assembly, Vienna, April 2017 Rahaghi, A. I., U. Lemmin, D. Bouffard, M. Riffler, S. Wunderle, and D. A. Barry Small-scale and mesoscale lake surface water temperature structure: Thermography and in situ measurements from Lake Geneva, Switzerland.

### UPCOMING IN 2018

In 2018, the Limnology Center would like to promote the following projects:

### Methane in Lake St Moritz

Lake St. Moritz in the Engadin area of Switzerland is famous for its "White Turf", a horse race during winter time on the ice. However, ice conditions have changed in recent years, with unexplained round structures being observed that affect the stability of the ice. A possible reason for these structures could be methane gas originating from within or below the lake in the deep geosphere. The Limnology Center will investigate these structures and methane gas in Lake St Moritz together with the European Tourism Institute of Switzerland at the Academia Engiadina (ETI AE) and scientists from ETHZ.

### **Experimental Platform LÉXPLORE on Lake Leman**

The goal of LéXPLORE platform on Lake Leman is to acquire physical, chemical and biological data at a high spatial and temporal resolution. This platform will also promote international and regional collaborations with other research groups.

In 2017, we needed two international calls for offers and negotiations to select the companies that will build the platform. By the end of the year, we selected three Swiss companies:

- Rampini & Cie for the circle of protection around the platform
- Shiptec AG to build and equip the pontoon
- ASN International GmbH to anchor the platform

The next steps are to sign the contracts and to start the construction. We hope that the platform will be anchored on Lake Geneva beginning 2019.







In parallel, a consortium agreement was signed between EPFL, University of Geneva, University of Lausanne and Eawag, to fund LéXPLORE. We are proud that four institutions will collaborate together on this ambitious project. At the same time, a steering committee (below) with one representative from each institution was created to conjointly manage LéXPLORE and the future scientific projects.



From left to right: Johny Wüest (EPFL), Damien Bouffard (Eawag), Marie-Elodie Perga (UniL), Natacha Tofield-Pasche (Project Manager), Bastiaan Ibelings (UniGE), Sebastien Lavanchy (Technical advisor)