



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.

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LIMNOLOGY Center

Ecole Polytechnique Fédérale de Lausanne

EDITORIAL

The year 2018 was a landmark in the development of the Limnology Center. On the one hand, we concluded the Life under Ice Project with a closing event after the ELLS-IAGLR conference in Evian in September 2018. It was an ideal opportunity to bring the local and Russian colleagues again together, with members of the FEEL Foundation. Also, end of 2018, the last Life under Ice manuscripts were accepted and our Inland Waters special issue will be published in 2019.

On the other hand, the Lake Geneva LÉXPLORE Platform took finally shape. During late 2018, the pontoon sections were transported to Bouveret Canal, where they were assembled and fully equipped. Already in July, a ring of marker buoys was installed off the coast of Pully, in order to protect LÉXPLORE from boat traffic and fishing nets. In the first weeks of 2019, we expect LÉXPLORE to be anchored, so that research projects by the four core partners from the Universities of Lausanne and Geneva, from EPFL and from Eawag can proceed.



9th October 2019: protection circle near Pully



24th October 2018: first section of LÉXPLORE Platform arrives in Le Bouveret

Experimental Platform LÉXPLORE

Rampini & Cie installed the protection circle against drifting nets at the end of July 2018. Unfortunately, due to a storm of ~70 years return time, the structure had to be reinforced and was fully operational on 5th October.

Within this 140 m diameter circle, researchers installed three different moorings on 11th October consisting of: (i) 24 thermistors, (ii) O₂-CO₂-PAR-Temp sensors, (iii) sediment traps. On 17th October, the optical profiler system Thetis with multiple sensors for bio-physical properties was successfully deployed. Data collection has finally started also in the upper water column, which was inaccessible before!



Deployment of Thetis



CO₂ and O₂ sensors

Shiptec AG finalized the construction of the pontoon on 21st December. It is equipped with a closed cabin with WC, 2 moonpools, 3 A-frames, 2 winches, solar panels and a soundproof generator. It has all the facilities to become a real floating laboratory! Currently in water in Le Bouveret at La Sagrave, it will be anchored near Pully on Lake Geneva at the beginning of 2019. Then the long-standing and international scientific adventure will finally start.



LÉXPLORE Platform floating in Le Bouveret

You will find more information on the dedicated website: www.lexplore.ch

We plan more communication events for next year, including a film about the construction of LÉXPLORE.

OUTCOMES

In 2018, researchers from the «*Life under Ice*» Project wrote their findings in peer-reviewed publications. For the project, we launched a special issue on Winter Limnology in *Inland Waters* journal. By the end of the year, four publications were accepted with one published, while four other manuscripts were under revision.

Natacha Tofield-Pasche participated in the organization of ELLS-IAGLR conference «*Big lakes – Small world*», where the Limnology Center was a sponsor. We also led the special session «**Challenging the cold: Advances in winter limnology of large lakes under climate change**». This conference was a great opportunity to present our project in 8 dedicated presentations and 3 posters.



Participants in the ELLS-IAGLR conference in Evian

CLOSING CEREMONY

On 28th September, this project was closed during an official ceremony. We were pleased that representatives from the sponsoring FEEL foundation, Frederik Paulsen, Patrick Aebischer and Pascal Couchepin, as well as 6 colleagues from the Northern Water Problems Institute came. The main findings were presented, and our Russian colleagues showed a special video on our joint project. This multidisciplinary and international project was a great success! We would like to especially thank Nikolay Filatov, Roman Zdorovenov and Vasiliy Kovalenko for their amazing commitment.

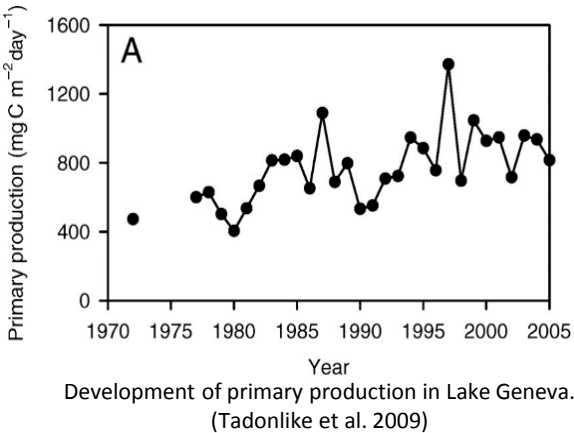


Group photo during the official closing ceremony of Life under Ice Project

PRIMARY PRODUCTIVITY IN SWISS LAKES

We started this new multidisciplinary project in 2018. The goal is to understand why the primary production in Swiss lakes has remained nearly stable while phosphorus concentrations have drastically dropped over the last decades. This project will be the first one connected to the facilities of the LÉXPLORE platform and is led by a consortium from EPFL, University of Lausanne, University of Geneva, University of Applied Sciences and Arts of Southern Switzerland, and Eawag.

The Limnology Center organized a first joint meeting on 28th May 2018 to create synergy between the participants, define research questions and identify potential gaps. To fill these gaps, the LIMNC launched a «*Call for Small Projects*». On 30th June, we received 8 project applications, of which the following four were selected for funding by LIMNC:



○ Dr. Fabio Lepori	Software for lake productivity
○ Prof. Frank Peeters	Primary productivity of different phytoplankton groups in Lake Constance
○ Prof. Bas Ibelings	Stoichiometric bottlenecks in the foodweb of Lake Geneva under impact of reoligotrophication
○ Dr. Daniel Odermatt	Whitening detection and optical characterization (w-doc)



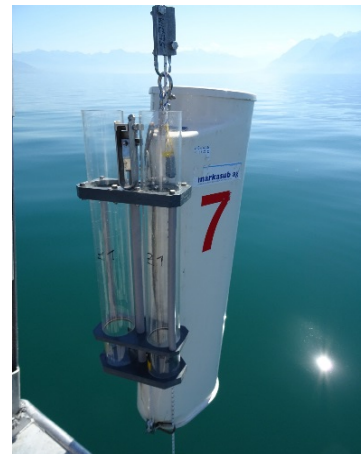
Whitening in Lake Geneva, observed by Landsat 8 (Nouchi 2018, doctoral thesis)

In total, the Limnology Center provided a funding amount of 172'000 CHF for these projects. A two-days workshop with the enlarged team is planned for mid-January 2019.

RESEARCH PROJECT:

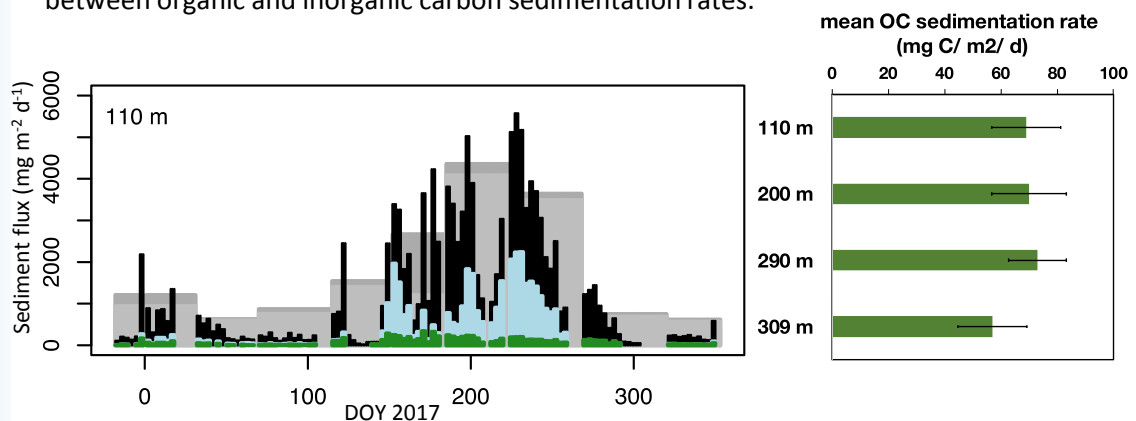
Organic matter sedimentation in Lac Léman

Sinking organic particles in Lake Léman may undergo bacterial degradation and contribute to deep oxygen depletion (DOP) in this large lake. In order to assess the contribution of organic carbon loss to DOP, the Limnology Center together with researchers from Eawag investigated the flux and the elemental composition of sinking particles in the hypolimnion of Lake Léman over more than an entire annual cycle. For this purpose, a mooring with sediment traps and temperature sensors was deployed at the lake centre from 2016 to 2017. Two sequential traps collected material at 110 and at 200 m water depth at 3-days intervals and four cylindric traps collected material at 110, 200, 290, and 309 m depth at monthly time scale.



Sediment trap setup in Lac Léman : The white bucket collected sediment samples at 3-day intervals and the opaque cylinders at 4 week intervals

The first results of this project show that about 0.6 kg of sediment was passing the hypolimnion per m^2 and year and that 50% of this sinking flux appeared during the summer months. Organic material accounted on average for 9 % of the total dry mass, whereas another 30% of the material consisted of calcium carbonate ($CaCO_3$). We did not find any major loss of organic carbon while sinking through the different water depths, which indicates that this flux might not contribute significantly to the DOP. Further analysis and additional collection of sedimenting material in the epilimnion of Lake Léman from LÉXPLORE platform will provide further insights into the relationship between organic and inorganic carbon sedimentation rates.



Variation of sedimentation rates (grey bars = cylindric traps, black bars= sequential traps) as well as $CaCO_3$ (light blue) and organic matter flux (green) at 110 m depth in Lac Léman over the year 2017. DOY = Day of year

Mean sedimentation rates of particulate organic carbon in the hypolimnion of Lake Geneva. Black bars indicate standard error

RESEARCH PROJECT:

Methane in Lake St. Moritz

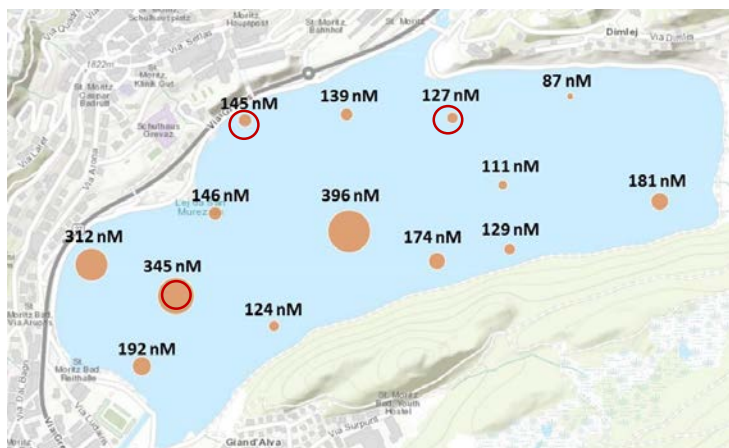


Hole structure in the ice-cover of Lake St. Moritz in January 2018. The whole was completely free of ice during the first sampling day but froze overnight

Together with the European Tourism Institute of Switzerland at the Academia Engiadina (ETI AE) the Limnology Center carried out two sampling campaigns on Lake St. Moritz during winter 2017/18. The aim of these campaigns was to solve the mystery of the ice-holes, which appeared in the lake ice-cover during the past few winters, and which poses a risk to humans and horses during the “White Turf”- a horse race on the lake each late winter. Three such holes (diameter ~50 cm), could be observed during the first campaign in January but none were observed during a later campaign in March 2018. A potential source for the holes, could be methane (CH_4) bubbles that rise from the lake bottom and prevent the freezing process at certain locations. To determine the amount, distribution and source of CH_4 in the lake, multiple water samples were taken and analyzed for CH_4 concentration and the isotope composition of the CH_4 -bound carbon.

The CH_4 concentrations were overall low in the water column ($< 100 \text{ nM}$), probably related to the high O_2 levels, which typically results in oxidation of CH_4 into carbon dioxide (CO_2) by bacteria. However, slightly higher and variable concentrations (100 - 300 nM) could be observed horizontally, directly under the lake ice cover and the isotopic compositions of the CH_4 -bound carbon may indicate that this methane originates from within the lake sediments. By ebullition, this CH_4 escapes a fast oxidation into CO_2 within the water column. Hence, the presence of methane bubbles may be confirmed for this lake. Whether CH_4 ebullition can be the major source of the lake ice holes, or if other physical processes play a role for their formations will be further investigated in winter 2019 and 2020.

Map of Lake St. Moritz with CH_4 concentrations (in nM, orange circles) measured directly under the lake ice-cover. Red circles indicate the locations where the ice-holes had been observed before. Figure taken from Bachelor Thesis of Laura Otth (ETH).



HUMAN RESOURCES: LIFE UNDER ICE

In Russia

Northern Water Problems Institute, KRC RAS, Petrozavodsk:

Physics group: Dr. Arkady Terzhevnik, Dr. Roman Zdorovenkov, Dr. Galina Zdorovenkova, Dr. Sergei Bodganov, Dr. Georgiy Kirillin

Hydrobiology group: Dr. Natalia Kalinkina, Dr. Tatjana Chekryzheva, Dr. Elena Tekanova, Dr. Maria Syarki, Dr. Andrey Georgiev, Andrey Sharov

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

Hydrology-climate group: Prof. Nikolay Filatov, Dr. Larisa Nazarova, Nikolay Palshin, Andrey Balagansky, Vasili Kovalenko, Sergei Volkov

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

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 Europe

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

OMP-LEGOS, Toulouse, France: Dr. Alexei V. Kouraev

University of Constance, Germany: Dr. Hilmar Hofmann

In Switzerland

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

Eawag: Dr. Nathalie Dubois, Mischa Haas, Alois Zwyssig, Dr. Beat Müller and Dr. Carsten Schubert, Michael Plüss, Serge Robert, Dr. Damien Bouffard, Dr. Love Råman Vinnå

Within EPFL

APHYS-Margaretha Kamprad Chair: Sebastien Lavanchy, Dr. Natacha Pasche, Dr. Hannah Chmiel, Dr. Hugo Ulloa, Prof. Alfred Wüest

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

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

HUMAN RESOURCES: PRIMARY PRODUCTION

In Germany

University of Constance: Prof. Frank Peeters, Dr. Hilmar Hofmann

In France

INRA-Thonon-les-Bains: Dr. Orlane Anneville

In Switzerland

University of Geneva: Prof. Bastiaan W. Ibelings, Ena Suarez Bolanos, Roxane Fillion

Eawag: Dr. Beat Müller, Dr. Damien Bouffard, Dr. Daniel Odermatt, Dr. Vincent Nouchi

University of Lausanne: Prof. Marie-Elodie Perga, Pascal Perolo, Dr. Thibault Lambert, Dr. Nicolas Escoffier, Gabriel Cotte

SUPSI: Dr. Fabio Lepori, Dr. Massimiliano Cannata, Dr. Camilla Capelli

Within EPFL

APHYS-Margaretha Kamprad Chair: Dr. Shubham Krishna, Dr. Natacha Pasche, Dr. Hannah Chmiel, Dr. Camille Minaudo, Prof. Alfred Wüest



Participants of Primary Production Project during the workshop on January 2019

SCIENTIFIC PUBLICATIONS

Inland Waters, Special issue on *Winter limnology: under-ice physical, geochemical and biological processes*

Camille Thomas, Victor Frossard, Marie-Elodie Perga, Tofield-Pasche Natacha, Hilmar Hofmann, Nathalie Dubois, Natalia Belkina, Serge Robert and Emilie Lyautey (2018): **Lateral variations and vertical structure of the microbial methane cycle in the sediment of Lake Onego (Russia)**, Inland Waters 10.1080/20442041.2018.1500227

Damien Bouffard, Galina Zdrovennova, Sergey Bogdanov, Tatyana Efremova, Sébastien Lavanchy, Nikolay Palshin, Arkady Terzhevik, Love Råman Vinnå, Sergey Volkov, Alfred Wüest, Roman Zdrovennov, and Hugo Ulloa (2018): **Under-ice convection dynamics in a boreal lake**, Inland Waters. DOI 10.1080/20442041.2018.1533356.

Nikolai Filatov, Vyacheslav Baklagin, Efremova Tatyana, Larisa Nazarova, and Nikolay Palshin: **Climate changes on the watersheds of lakes Onego and Ladoga based on the remote sensing and in-situ data**, Inland waters. DOI 10.1080/20442041.2018.1533355 (in press)

Ena Lucia Suarez, Marie-Caroline Tiffay, Nataliia Kalinkina, Tatjana Chekryzheva, Andrey Sharov, Elena Tekanova, Maria Syarki, Roman Zdrovennov, Elena Makarova, Evanthia Mantzouki, Patrick Venail and Bastiaan Ibelings: **Diurnal variation in the convection-driven vertical distribution of phytoplankton under ice and after ice-off in large Lake Onego (Russia)**, DOI 10.1080/20442041.2018.1559582. Inland Waters (accepted)

Other journals

Hugo Ulloa, Alfred Wüest, and Damien Bouffard (2018): **Mechanical energy budget and mixing efficiency for radiatively heated ice-covered waterbody**. Journal of Fluid mechanics, 852. <https://doi.org/10.1017/jfm.2018.587>

Volkov Sergey, Sergey Bogdanov, Roman Zdrovennov, Galina Zdrovennova, Arkady Terzhevik, Nicolay Palshin, Damien Bouffard, Georgiev Kirillin (2018): **Fine scale structure of convective mixed layer in ice-covered lakes**. Environmental Fluid Mechanics. <https://doi.org/10.1007/s10652-018-9652-2>.

CONFERENCES

Life under ice project

‘Big Lakes - Small World’: ELLS-IAGLR-2018, 23rd – 28th September 2018, Evian, France.

Marie-Elodie Perga, Maria Syarki, Jorge Spangenberg, Victor Frossard, Nataliia Kalinkina, Damien Bouffard. **Zooplankton feeding and overwintering strategies under lake ice.**

Ena Lucia Suarez, Marie-Caroline Tiffay, Nataliia Kalinkina, Tatjana Tchekryzheva, Andrey Sharov, Elena Tekanova, Maria Syarki, Roman Zdorovenov, Elena Makarova, Evanthia Mantzouki, Patrick Venail and Bastiaan Ibelings. **Diurnal variation in the convection-driven vertical distribution of phytoplankton under ice and after ice-off in large Lake Onego (Russia).**

Natalia Belkina, Camille Thomas, Nathalie Dubois, Daniel Ariztegui, Hannah Elisa Chmiel, Natacha Tofield-Pasche, Natalia Kulik and Anastasia Sidorova. **Organic matter degradation in sediments of Lake Onego.**

Sergey Bogdanov, Sergey Volkov, Roman Zdorovenov, Arkady Terzhevnik, Tatyana Efremova, Galina Zdorovenova, Nikolay Palshin, and Damien Bouffard. **Large scale structure of radiatively – driven convection under ice.**

Nikolai Filatov, Vyacheslav Baklagin, Efremova Tatyana, Larisa Nazarova, and Nikolay Palshin. **Climate change on the watersheds and hydrological features of lakes Onego and Ladoga based on remote sensing and in situ data.**

Sergey Volkov, Sergey Bogdanov, Arkady Terzhevnik, Galina Zdorovenova, Roman Zdorovenov and Georgiy Kirillin. **On ADCP capabilities of estimating turbulence parameters in fine-scale and energy-containing ranges.**

Roman Zdorovenov and Alexei Kouraev. **Ice conditions and organisation of scientific work on ice-covered lakes.**

Hannah Elisa Chmiel, **Spatiotemporal variability in CO₂ distribution and gas exchange in the inflow area of a large boreal lake.**

Nataliia Kalinkina, Nikolay Filatov, Elena Tekanova, and Andrei Georgiev. **The current brownification processes in the nearshore part Of Lake Onego (Russia).** Poster.

Natalia Kalinkina, Maria Syarki, and Andrey Sharov. **The plankton state under ice-cover large oligotrophic lake.** Poster.

Tatyana Efremova, Albina Sabylina, Peter Lozovik, Vera Slaveykova, M. Zobkova, and Natacha Pasche. **Seasonal and spatial patterns of hydrochemical variables in Lake Onego (Russia): insights form 2016 campaigns.** Poster.

CONFERENCES

Life under ice project

Haas Mischa, Ajallooeian Fatemeh, Belkina Natalya, Subetto Dmitry, Dubois Nathalie (2018), **From plowing to grazing: An example of land-use relaxation and its effect on soil stabilization and the recovery of Lake Lavijärvi, Russia Karelia**. IPA-IAL Conference, Stockholm, Sweden, 18th to 21st June 2018. Poster.

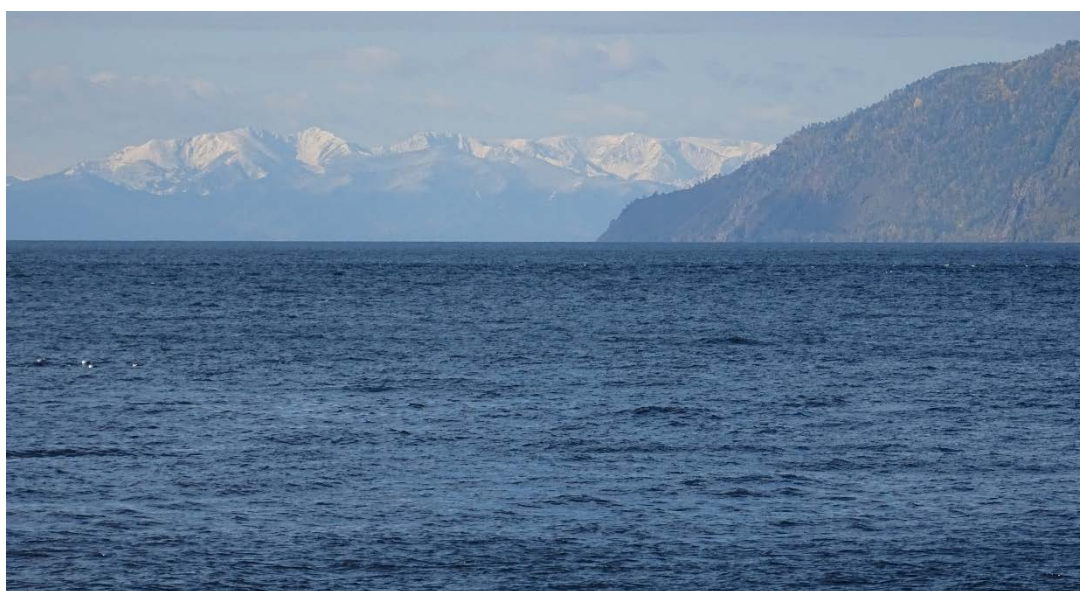
Nikolai Filatov, Tatyana I. Regerand. **Restoration of Eutrophic Lakes: Current Practices and Future Challenges**. Lahti Lakes 2018. 4-6 June 2018 in Lahti, Finland.

Sergey Volkov, Galina Zdrovennova, Roman Zdrovennov, Tatyana Efremova, Nikolay Palshin, Arkady Terzhevik, Damien Bouffard, Sergey Bogdanov. **Radiatively driven under-ice convection: the impact of lake depth**. 21st Workshop on Physical Processes in Natural Waters, Solothurn, Switzerland, 20th to 24th August 2018.

Nikolai Filatov. **Present-day state and changes of the largest lakes of Europe: problems and solutions**. International conference. Freshwater ecosystems – key problems. Irkutsk, Listvyanka, Russia 10-14 September 2018.

Other

Natacha Tofield-Pasche. **The Limnology Center – an attractive research partner with new technologies**. Baikal International Ecological Water Forum, Irkutsk, Russia, 19-21 September 2018.



Lake Baikal: view on the snowy southern mountains from Listvyanka

Experimental Platform LÉXPLORE

the scientific adventure starts !

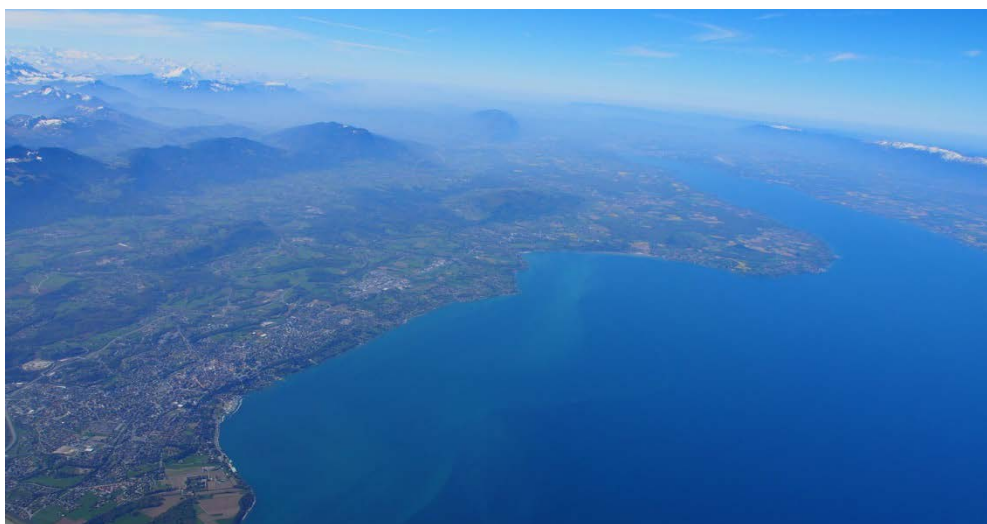


LÉXPLORE Platform ready in Le Bouveret

In 2019, the LÉXPLORE platform will be anchored and fully operational. The LÉXPLORE steering committee is looking forward to promote international and state-of-the art research on Lake Geneva.

The primary production project will greatly benefit from this infrastructure. To further promote the use of LÉXPLORE, the Limnology Center plans to finance an internal call within EPFL in 2019.

Regarding the communication, a special event is planned for June 2019, to inaugurate LÉXPLORE with VIPs from the four participating institutions – University of Geneva, University of Lausanne, EPFL and Eawag. At this point, the film about the construction of LÉXPLORE will be finalized and the first results will be presented.



Lake Geneva from the air, taken within the ULM project