Projet SIE and Projet de Master SIE 2018

A 3D online monitoring and forecasting system for Lake Neuchatel

Projet N° APHYS_1 (7067)
Catégorie de projet : Projet étudiants SIE
Type de projet : Projet de Master
Responsable : Theo Baracchini, Alfred Wüest

Descriptif du projet :
Meteolakes.ch is a new online platform for monitoring and forecasting the bio-physical state of Swiss Lakes. Used by more than 200 inhabitants every day, and available on Android, *Meteolakes* provides now unique environmental information in real-time to scientists, lake stakeholders, but also to the public and local fishermen. Although *Meteolakes* has been critically acclaimed by media and the public, one thing seems to be missing: Lake Neuchâtel (currently Lake Geneva, Biel and Greifensee are available).

Lake Neuchâtel is the largest entirely Swiss lake, and a crucial element for the wellbeing of the numerous inhabitants of the region and its economic development. In addition to being at the core of various scientific studies (for example the mysterious craters have been discovered at its bottom in 2015), the lake is also subject to increasing anthropogenic pressures, such as the influx of nutrients, and various pollutants, alterations of hydrological regimes and topography, or changes in heat budget.

By developing a 3D hydrodynamic model for the lake with existing tools, the student will contribute to the understanding of the hydrodynamics and regime of such ecosystem, which is under anthropogenic pressure both on a local scale through human influence and globally through global warming. The outcome of the thesis will be a new tool for monitoring the status of the lake, which will allow to follow its stratification in real-time as well to forecast its dynamics over 4.5 days or under different climate change scenario.

In addition to that, this project will have a unique and direct impact on the inhabitants, fishermen, and lake managers of the region as it will then be available online on meteolakes.ch, thus answering a real public need and providing real-time environmental information for the benefit of all.

Validating Lake Geneva's 3D hydrodynamic & water quality model with in-situ measurement stations

Projet N° APHYS_2 (7068)
Catégorie de projet : Projet étudiants SIE
Type de projet : Projet SIE or Projet de Master
Responsable : Theo Baracchini, Damien Bouffard, Alfred Wüest

Descriptif du projet:
With the United Nation's Post-2015 Development Agenda, and the EU water Framework Directive, political actions towards surface water monitoring frameworks and sustainable management are now at the core of societal debates and preoccupations.

Lake Geneva, the largest lake of Western Europe, is under constant pressure from over one million residents living nearby and is thereby an ideal test case for research. Historically, monitoring was performed with single punctual *in-situ* measurements, usually sampled in the middle or the deepest location of the lake, at bi-weekly and often lower frequencies. While tremendous knowledge was gathered, the spatial and temporal (below

seasonal scale) variability remained inaccessible from these measurements. The monitoring of such mesotrophic system, which is still recovering from eutrophication of the last century, at finer spatio-temporal scale is therefore required in order to catch its complex dynamics. To answer that need, we developed an online real-time 3D hydrodynamic model using MétéoSuisse weather data as input (*meteolakes.ch*). However, the accuracy of this predicting model is unfortunately limited by the lack of validation data.

The aim of this project is to validate this model. This will be done by contacting operators of existing sampling stations (operated by waste water treatment plants, drinking water intakes, etc.) in order to collect field data and compare it with the existing model to ensure its robustness. An analysis of the temporal dynamics and a comparison with the model will allow to discuss the relevance of the existing sampling locations. Finally, thanks to those field measurements, the quality of the predictions will also be assessed in order to quantify the forecasting potential of such modelling tool over 4.5 days.

Surface structures on Lake Geneva

Projet N° APHYS_3 (7069)
Catégorie de projet : Projet SIE
Type de projet : Projet SIE or Projet de Master SIE
Responsable : Hugo Ulloa, Alfred Wüest

Descriptif du projet:
Different relevant physical and biogeochemical processes in lakes can be detected by observing the surface water. For instance, currents, biomass, and inert-mass transported through the aquatic system can print a signature on the surface. This surface signature is associated with changes in apparent water colour and surface patterns.

With the goal to link surface water pattern to physical and biogeochemical processes in Lake Geneva, a camera was deployed at Caux Conference Center (close to Montreux) to observe the eastern basin and the Rhone River inflow, covering approximately 9% of the lake surface. The deployment includes a GoPro Camera attached to a Timer and powered by an external battery/Solar Panel system. The system has been set for shooting every 5 min, between 5AM-11PM Mon-Sun, allowing an autonomy of 50 days. The first time-lapse obtained from the deployment, the Large-Scale Surface Observer (LS2-O), is found at the following link: https://youtu.be/sPLzbr7cvxA

The aim of the master project is to systematise the surface pattern detection to detect time/localization, span and length-scale of events such as eddy and gyre-like patterns, algae blooms and suspended sediment. The detected events will be compared with a three-dimensional numerical model (meteolakes.epfl.ch) as well as the available observational data.

Seasonal deep-mixing in Lake Lugano: effects of turbidity and climate change

Projet N° APHYS_4 (5139)
Catégorie de projet: Projet SIE
Type de projet : Projet de Master SIE, Projet de Semestre SIE
Responsable : Robert Schwefel, Alfred Wüest, Damien Bouffard

Descriptif du projet:
Focus 1: Deep-mixing events (overturns) are critical for in the physical, chemical and biological characteristics of lake ecosystems. These events are strongly influenced by climatic factors including global warming. In Lake

Lugano (Switzerland and Italy), two exceptional turnover events have been observed in recent years. First, the north basin of the lake, which is usually never mixes completely, turned over for the first time during the winter of 2005/06. Second, the south basin, which is usually monomictic (i.e., it mixes once a year), failed to turn over during 2014. In either case, these exceptional events had severe consequences for the lake ecosystem, e.g. for the phosphorus content of the water column. The main goal of this project is to identify the causes of these exceptional events. The work will make use of climate and lake-temperature data with high temporal resolution (bi-weekly to monthly) from the last 40 years

Focus 2: In the past few decades, both the global climate as well as the water quality - and related the turbidity - have changed. As a result, lake water surface temperatures have generally increased. But often it is not obvious to what extent climate or turbidity had an effect and which depth ranges were affected. The goal of this project is to explain why in many lakes the temperature at the surface has increased by about 0.04 °C/yr, whereas at about 20 m depth the temperature has decreased despite the global warming. The work will include both hydrodynamic modelling as well as analysis of data from the last 50 years.

Formation of ice in Swiss lakes

Projet N° APHYS_5 (6361)

Catégorie de projet : Projet SIE

Type de projet : Projet de Master SIE, Projet de Semestre SIE

Responsable : Damien Bouffard, Alfred Wüest,

Descriptif du projet:

Time series of ice covers of lake contain important climatological information (Frassen and Scherrer, 2008). The goal of this master project is to determine the main mechanisms governing ice formation and duration over 6 lakes in Switzerland. Especial the weeks and days before the first formation are very crucial for the initiation of the ice formation, which therefore depends on various parameters. The project includes analyse of in-situ data as well as parametrization and validation of one dimensional lake hydrodynamic models. The student will participate to field measurements on the selected alpine lakes.

The master project can be at Lausanne (EPFL) or Kastanienbaum (Eawag) and will be supervised by Prof A. J. Wüest and Dr D. Bouffard.

Semeter - Surface temperature variability in lakes

Projet N° APHYS_6 (6362)

Catégorie de projet : Projet SIE

Type de projet : Projet de Master SIE, Projet de Semestre SIE

Responsable : Damien Bouffard and Alfred Wüest,

Descriptif du projet :

The goal of this project is to investigate the spatio-temporal variability of lakes by using surface temperature data collected by the ferry boats on Lake Lucerne (operated by SGV) and on Lake Geneva (operated by CGN)

in combination with three dimensional hydrodynamic modelling (see online model on meteolakes.epfl.ch) and late surface water temperature by satellite sensors.

The master project can be at Lausanne (EPFL) or Kastanienbaum (Eawag) and will be supervised by Prof A. J. Wüest and Dr D. Bouffard.

Mixing by bacteria in Lago di Cadagno, Ticino.

Projet N° APHYS_7 (5151)
Catégorie de projet : Projet SIE
Type de projet : Projet de Master SIE, Projet de Semestre SIE
Responsable : Tobias Sommer, Alfred Wüest

Descriptif du projet

The goal of this project is to investigate mixing caused by bacteria in Lago di Cadagno, a small mountain lake in Ticino, Switzerland. Mixing has been observed previously in a ~1 m thick layer at 12 m depth, which is exactly where *Chromatium okenii*, 10 □m large bacteria, are located. Mixing by bacteria has never been observed in nature, but is known from laboratory studies under the name of bioconvection. Three conditions must be fulfilled for bioconvection: (i) Bacteria are denser than water; (ii) the concentration of bacteria is large enough; (iii) the bacteria preferentially swim upward.

The goal of this project is to measure the yearly cycle of bacterial concentration and density and relate those two quantities to the intensity of mixing. The work involves weekly field work under partly harsh alpine weather conditions (water samples, profiles of temperature, conductivity, turbidity) as well as lab work (microscopy, pipetting, centrifugation for density determination).

The work place will be Kastanienbaum, the applicant must have a driving license and the optimal time interval is May to October 2016.