



МЕЖДУНАРОДНЫЙ ЦЕНТР ДАННЫХ  
ПО ГИДРОЛОГИИ ОЗЁР И ВОДОХРАНИЛИЩ  
INTERNATIONAL DATA CENTRE  
ON HYDROLOGY OF LAKES AND RESERVOIRS

## ANNUAL NEWSLETTER

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Dear reader! We would like to offer to your attention to the next eleventh edition of the Annual Newsletter, at the beginning of which the state and replenishment of the Center's database is traditionally highlighted, as well as the development of its IT-structure.

In 2021, the Center's database was replenished with both the results of *in-situ* observations, which make up the bulk of it, and data from satellite observations of the water level obtained from the LEGOS laboratory of the National Space Agency of France (CNES).

The J.-F. Crétaux's article from LEGOS laboratory contains information on the further development of the project for the research of lakes using satellites, which are carried out within the framework of the international program «Climate Change Initiative» (CCI). The study is based on a comparison of satellite and *in-situ* observations of lake water levels. At this stage, it is studying how the accuracy of satellite data has improved due to the launch of new high-resolution satellites.

In the autumn of 2021, the seventh meeting of the International Steering Committee of the HYDROLARE was held. This release provides short information on the results of the meeting held in the videoconference format.

In conclusion, as always, I would like to express my sincere gratitude and appreciation to the representatives of the organizations that cooperated with the Centre.

*Prof. Valery Vuglinsky*  
*Director of HYDROLARE*



Lake Kiyovo (Russia)

## DEVELOPMENT OF THE CENTRE'S IT INFRASTRUCTURE

*L. Barinova, G. Barinova, E. Kuprienok (HYDROLARE, Russia)*

At the Centre, work continued on the collection, analysis and preparation of data, as well as on their transformation to the single type required for loading into the HYDROLARE database. As before, search, recognition and collection of data on water levels and water temperature from the websites of relevant services of Canada, Slovenia, Sweden and the United States was continued. In addition to the data previously received, data on various elements of the regime of lakes and reservoirs of Belarus for 2019 and Switzerland for 2018 were received.

The database was replenished with information on water levels in Belarus (10), Switzerland (33), Slovenia (2), Sweden (6), Canada (15), USA (43), Russia (104), as well as with water levels of lakes in Russia, averaged over the water bodies (11).

Data on the average monthly and maximum water temperature were prepared and uploaded for the stations of Belarus (10), Slovenia (2) and Russia (18).

For the Caspian Sea, data on water levels and temperatures have been loaded for 12 and 10 stations of riparian countries, respectively.

The database was also replenished with data on the maximum ice thickness at the stations of Belarus (20), Estonia (17), Moldova (6) and Russia (48).

In the framework of international cooperation with the LEGOS Laboratory, the Centre received satellite water level observations from 37 water bodies around the world. For 9 of them, data were received for the first time.

Including data received earlier, the total number of water bodies with satellite observations reached 87 and the number of countries in which they are located reached 35.

In total, the Center's database contains observational data on 1,050 lakes and reservoirs in 46 countries.

In accordance with the recommendation of the International Scientific Steering Committee of the Center, the existing search system has been perfected, which allows determining the data source for each hydrological station. Access to information about all data sources is carried out through the cartographic interface on the page "Organizations holding data on hydrology of lakes and reservoirs".

On Google's map, the organizations that provided the data are designated with markers, by clicking on which you can see the name of the data provider (Figure 1). On the same page there is a list of these organizations with links to their websites available for download.

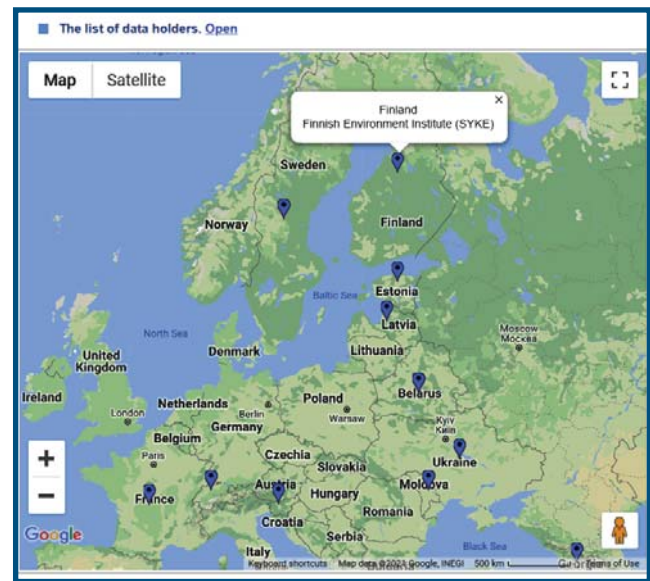


Figure 1. Organizations - data holders

The Center's website contains a list of unregulated (natural) water bodies considered as climate change indicators (ECV-Lakes) as part of the international GCOS (Global Climate Observing System) programme. Information about 79 water bodies located in 43 countries can be obtained through an interactive cartographic interface.

For each water body marked with a token, its coordinates, height above sea level, water surface area, as well as the information about the availability of observational data are accessible (Figure 2).

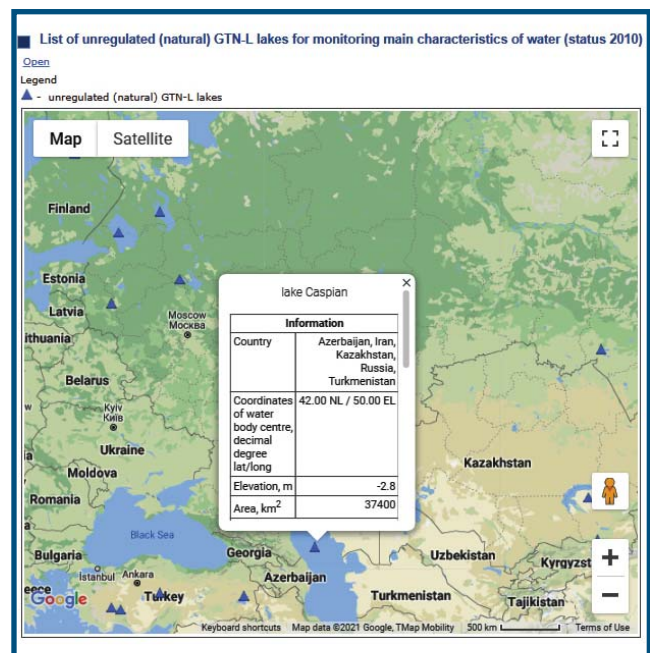


Figure 2. Water bodies - climate indicators (ECV-Lakes)

## LAKE SURVEY FROM SATELLITES: THE CCI PROJECT AND FRENCH-RUSSIAN GRANT

J.-F. Crétaux, (LEGOS/CNES, France)

The LEGOS laboratory and the State Hydrological Institute (SHI) participate to an ESA (European Space Agency) project on lakes survey from satellites under the framework of the CCI (Climate Change Initiative) programme. The purpose of this program is to develop a methodology for correcting satellite observations based on their comparison with ground data on the example of large lakes. Satellite data will be provided by the LEGOS laboratory and *in-situ* by the HYDROLARE Data Center.

An integrated database has been created containing long-term average monthly and average annual water levels of large lakes of the planet. This database is importance for execution of the GCOS Project Implementation Plan and the development of the GTN-H (Global Observing Network – Hydrology) initiative.

A Terrestrial network of measurements of water level in lakes is needed to improve our knowledge for the water balance of these water bodies, the role of lakes in climate formation on the globe, but *in-situ* observations are declining around the world. Many studies showed that satellite data can complement *in-situ* networks. At the same time, satellite data are distinguished by large distances between tracks (from 50 km to 350 km at the equator) and long time intervals (the orbital turnover period is from 10 to 27 days). Satellite measurements are not affected by weather conditions, however, the technique of

processing satellite data may be associated with a number of limitations. In addition, such data often have significant errors associated with both technical errors of the measurements themselves and methodological problems of data processing.

The accuracy of satellite measurements of the water level of lakes varies greatly under the influence of many factors: rapidly changing underlying surface, instrument errors, etc.

As part of the CCI program, a quantitative assessment of the accuracy of satellite measurements, a comparison of satellite and *in-situ* lake water level data and an improvement in the methodology for correcting satellite data to increase their accuracy should be carried out. The latter depends both on the design of the altimeters and on a special algorithm designed to process satellite measurements

In 2016 and 2018 ESA launched two satellites: Sentinel-3A and Sentinel-3B, each of which will operate for 12 years. This ensures the continuity of the time series of measurements for almost a quarter of a century, since they will be followed by a series of two other satellites: Sentinel-3C and Sentinel-3D. These satellites are equipped with high-precision radar altimeters SAR (Synthetic Aperture Radar), which are much more accurate than the classic low-resolution (LRM) radars used in earlier missions such as Topex/Poseidon, Jason (1, 2, and 3) or Envisat.

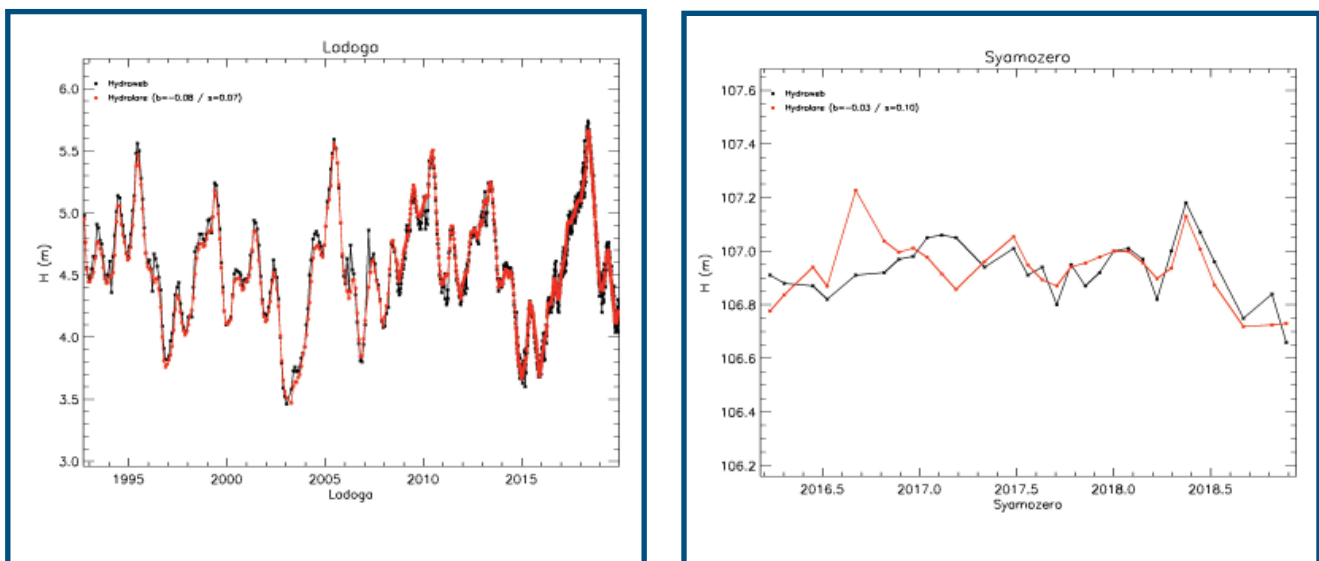


Figure 3. Preliminary results of intercomparisons of satellite and *in-situ* data on the water level of Ladoga and Syamozero



The processing of data obtained in high resolution mode, performed at CNES with the participation of LEGOS, demonstrated an increase in the accuracy of measurement data by 2 to 5 times for small lakes with an area of several hectares. This opens up promising prospects, as there are opportunities to expand monitoring of changes in the water levels of hundreds of lakes on a global scale. (Boy F., Crétaux J.-F., Boussaroque M., & Tison C., 2021, Improving Sentinel-3 SAR mode processing over lake using numerical simulations, in press, IEEE).

Satellite altimetry has a long history of monitoring lakes levels, which has created long-term series of satel-

lite observations that are widely used by the scientific community in the CCI project. One of the goals of the Russian-French cooperation within the CCI project is to determine, using *in-situ* observation data, how much the accuracy of data obtained with the help of new satellites can increase compared to previous missions. This work is carried out on the example of three dozen lakes located mostly in the north-west of the Russia. The first results of the study showed that at present satellite data allow us to obtain centimeter accuracy when measuring water levels on large lakes and decimeter accuracy on small ones (Figure 3).

## SEVENTH MEETING OF THE INTERNATIONAL SCIENTIFIC STEERING COMMITTEE OF HYDROLARE

V. Vuglinsky (*HYDROLARE, Russia*)

The seventh meeting of the International Scientific Steering Committee (SSC) of the WMO for the International Data Center on Hydrology of Lakes and Reservoirs (HYDROLARE) was organized by the State Hydrological Institute (SHI) via videoconference and was held on October 27, 2021 (due to the coronavirus pandemic in 2019, the SSC meeting was not held).

The Director of the Center, Professor V. Vuglinsky made a report on the activities of the Center for the period from August 2017 (after the sixth meeting of the Steering Committee) to October 2021.

Information on the formation and maintenance of the database and development of IT-infrastructure, including the Center's website was presented by the Center's employees E. Kuprienok and L. Barinova. Among the main achievements of the Center were noted:

- continued data collection from WMO member countries and their loading into the database;
- continuing cooperation with the LEGOS laboratory;
- ensuring the continuous functioning of the English-language website of the Center, including means of informing users about the current contents of the database;
- ongoing cooperation with WMO and the GCOS Programme on matters related to the activities of the Centre;
- preparation and publication of regular release of the HYDROLARE Annual Newsletter (for 2018, 2019 and 2020).

The meeting participants highly appreciated the activities of the Center since the sixth meeting of the SSC.

A representative of WMO, D. Berod (Switzerland) made a presentation on the development of new hydrological structures as part of the restructuring of WMO, its aims, objectives and prospects for international cooperation in hydrology. He emphasized the important role of global hydrological centers in the implementation of the WMO hydrological program.

The representative of the Federal Institute of Hydrology, T. Recknagel (Germany), made a presentation on the development of the network of global hydrological data centers of the GTN-H. The current status and prospects of the Global River Runoff Center (GRDC) were presented by the Director of the Center, U. Looser (Germany).

The Deputy Director of the LEGOS laboratory J.-F. Crétaux (France) described the activities of the laboratory on monitoring lake levels using satellite altimetry data.

The presentations were followed by a general discussion on various aspects of HYDROLARE's activities and agreement was reached on the main directions for the future development of the Centre for 2021-2023. The report of the seventh meeting of the Scientific Steering Committee for the International Data Center on the Hydrology of Lakes and Reservoirs will be posted on the official website of the Center: [www.hydrolare.net](http://www.hydrolare.net)