Newsletter

1/2021

10 YEARS CzechGlobe

Global Change Research Institute CAS

BACK TO NORMAL? ONLINE FOR NOW.

It used to be the rule in CzechGlobe that at the beginning of the year we would always plan events such as conferences, professional seminars or exhibitions,i.e. events where a larger number of participants is expected. However, this year everything was different. The ongoing pandemic, at least for the first half of the year, either completely put a stop to these activities or limited them to an online form. Nevertheless, it should be noted that with regard to the situation, this time we reckoned with it almost with certainty and were able to deal with it with honor. In this way, we managed to organize, with a one-year delay, for example, the international conferences Bioeconomy and Circular Economy and the 6th Forum Carpaticum.

Another cleared backlog from last year is the completion of the CzechGlobe evaluation within the assessment of research and professional activities of the Academy of Sciences (for the period 2015-2019). It takes place in regular five-year cycles and should have been completed already in 2020. Coincidentally, at that time, we commemorated 10th anniversary of the CzechGlobe founding and because that time did not favor any celebrations, we have dedicated at least this year's issues of the Newsletter to the remembrance of interesting results achieved. The evaluation of academic workplaces takes place in two phases and the second phase consists of a visit by an international field evaluation committee directly to the workplaces where the individual teams present themselves. It was this part of the evaluation that had to be postponed last year. Unfortunately, the circumstances this year did not allow for such presentation in person either, and everything was carried out online. For the evaluated period, the GCRI grouped researchers into three thematic teams representing i) climate analysis and modeling, adaptive and innovative techniques, ii) environmental effects on terrestrial ecosystems and iii) the human dimension of the impacts of global change. We had devoted a great deal of effort to the preparation for the evaluation, knowing that an excellent result would help CzechGlobe balance the score between the institutional financial support and targeted funding through acquired projects. This unfavorable disproportion was, among other things, addressed by the director of GCRI in his interview published in the last issue of our Newsletter. The final report came off as very positive for us. The evaluation highlights the "unique comprehensive approach to solving problems" and

states that *"there are not many similar institutions abroad and it is completely unique in the Czech Republic"*. It sees the strengths of the institute in the methodological background of analytical laboratory equipment and the network of measuring stations, as well as in the scientific level of outputs. On the other hand, the results of the evaluation were not reflected in the proposal to adjust the low institutional funding… Thus, this practically means maintaining the status quo and it is therefore not surprising that the whole experience leaves us feel rather disappointed and counterproductive. Hence, e.g., the two newly obtained ISO certificates in the field of quality management and environmental management might be more likely to help us on the way to better financial security.

One of the events of global significance that was postponed due to the pandemic is the COP 26 climate summit, which is convened for November this year in Scottish Glasgow. Among other things, world political leaders and climate change experts should assess how the goals of the Paris Agreement of 2015 are being met. Although we did not feel this way in the Czech Republic, according to the www.inpocasi.cz portal, 2020 was together with the year 2016, globally, the warmest years in the history of measurement, and in Europe 2020 was the hottest year ever. Compared to the second half of the 19th century - the pre-industrial period - 2020 was already 1.25°C warmer, which is only a quarter of a degree less than the more ambitious limit to keep warming below 1.5°C set by the mentioned Paris Climate Agreement.

In connection with the organization of the summit, the Cambridge Sustainability Commission report on Scaling Behaviour Change has been met with great interest in the United Kingdom. The report makes recommendations to address the climate crisis issues and calls on policy makers to provide affordable low-carbon alternatives for low-income households and to target the biggest polluters in the UK in order to move towards more sustainable behavior. Paradoxically, some of the biggest polluters of the environment are supported by the local government through tax reliefs.

Julia Mildorfova Leventon, Head of the Human Dimension of Global Change Department at CzechGlobe, was also a member of the Cambridge Commission involved in preparing the report. Another proof that the research topics of this department are current, beneficial and interesting has been the recent success of two other scientists from this group, Zuzana Harmáčková and Lenka Suchá. Zuzana is a recent winner of the Otto Wichterle Award given by the Czech Academy of Sciences to young scientists under 35 and Lenka was nominated by the Academy of Sciences in the competition of the best work of young Czech scientists in the Environmental and Climate Research for 2021. This *Make Our Planet Great Again* Prize is awarded by the French Embassy. Our sincere congratulations to both of them. -mš-

Meet one of us

ING. JAN HANUŠ

Jan Hanuš studied geodesy and cartography at the Faculty of Civil Engineering of the Czech Technical University in Prague. He has been working at GCRI since 2005. He first worked in the Department of Remote Sensing, where, among other things, he was instrumental in the establishment of the airborne laboratory. Since 2017 he has been the head of the Department of Flight Activities. He is a member of the Executive Board of the European Facility for Airborne Research EUFAR AISBL.

Remote sensing is a modern and constantly evolving field. What development has it gone through in CzechGlobe?

Remote sensing has been developing at our Institute for quite a long time, and initially satellite data was mainly used. A qualitative change occurred when the AISA Eagle hyperspectral sensor was purchased in 2004. At that time, I joined the Institute as its first operator. The beginnings were interesting. For the airborne use of the sensor, there was always tug-of-war over the most suitable days for scanning between us and the photogrammetric company from which we rented the aircraft. In the case of ground use of the sensor, we had to assemble the structure from ladders in order to achieve a minimum four-meter-distance for proper focusing. In 2010, thanks to the Structural Funds of the European Union (OP RDI), we had the opportunity to build a real airborne spectroscopic laboratory with our own airborne sensor carrier Cessna 208B Grand Caravan. The sensor equipment was expanded from visible and near infrared to mid- and long-wave (thermal) infrared. As a result, our capabilities improved rapidly in terms of image quality and quantity. Another significant step in the development of the laboratory was the installation of a laser scanner. The automation of sensing in an aircraft is currently at a high level, as evidenced by the fact that the four sensors installed in our aircraft, including a number of ancillary systems, can be operated by a single operator.

Recently, there has been a great expansion of unmanned aerial systems (UAS), which are especially suitable for scanning smaller areas and for application use. Miniaturization and automation have reached such a level that we are able to install a regular hyperspectral sensor on the UAS. The UAS can be programmed to the extent that it can perform autonomous data collection, including take-off and landing. Robotization is therefore widely used also in the field of remote sensing and will continue to develop. However, from a practical and legislative point of view, permanent pilot supervision is still necessary.

What are your tasks specifically?

Our Department of Flight Activities is primarily responsible for the operation of the Airborne Laboratory (FLIS). Our task is to capture and process data in such a way that it can be used by scientists for analyses. It all starts with the most appropriate flight planning for the given purpose. One of the most problematic tasks is the actual collection of image data, where we must select the most suitable time to capture the images. For most purposes, it is necessary to perform sensing under completely cloudless skies. If our goal is to capture, for example, bare soil, then a "flight window" opens for the collection of data for approximately two spring weeks before the sown crops come out. Capturing good quality data thus depends primarily on the permanent readiness to perform data acquisition as soon as suitable conditions occur. We must also be able to correctly estimate the development of the weather (especially low cloud cover) so that there are optimal conditions at the time when the aircraft gets over the area of interest. The most time-consuming task is data management, where radiometric, atmospheric and geometric corrections must be performed. Even data which was captured under sub-optimal conditions can be partially recovered. When processing data, it is again true that it is always necessary to process it with regard to the purpose of its use.

What data do you capture and what is its use?

At CzechGlobe, we use data primarily for vegetation analyses. For forestry applications, the combination of hyperspectral systems and a laser scanner is very advantageous. Laser data will provide us with information about the structure of the forest stand (height, shape, etc.), which can be used, for example, to estimate the amount of biomass. Hyperspectral data, in turn, provide information on the current health of the stand, and thanks to the resolution of airborne data, this information can be obtained at the level of individual trees. In agriculture, hyperspectral data is mainly used for applications of precision agriculture. The data can also be used, for example, for pedological purposes or to estimate the water quality of water bodies (e.g. by detecting cyanobacteria). A separate chapter is the use of airborne data in the urban environment. At present, there is a growing interest in thermal data, which clearly show the creation of the so-called heat islands in places with a minimum of greenery during the summer months. Laser data to determine the structure and hyperspectral data for the detection of individual surface types is also very useful. It can be used to create temperature maps of cities. You can see the temperature map of Brno at: http://mapserver.czechglobe.cz/map/brno/2015-07-07/hs-lwir.

Remote sensing is certainly an interesting discipline. Would you recommend it to those interested in science?

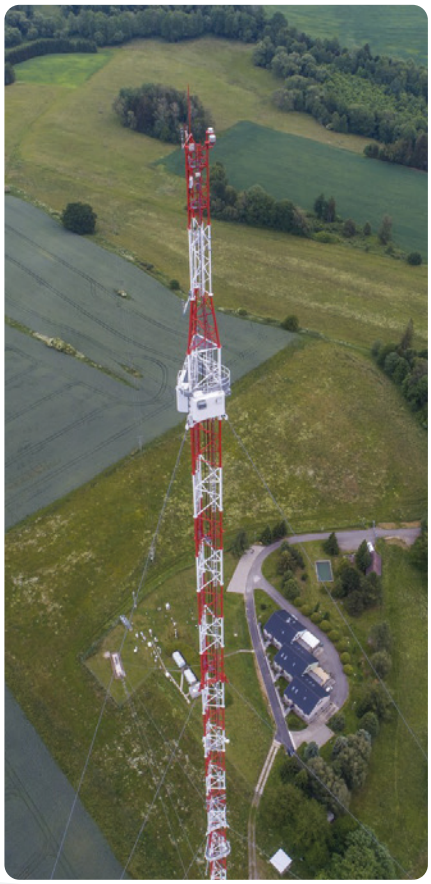
Remote sensing is an extremely dynamic and growing field, which promises further development opportunities in the future at the level of unmanned aerial systems, aircrafts or satellites. The ever-changing field offers prospect of application and utilization of data to interested students, researchers and the professional public. I personally moved from Prague to Brno for the opportunity to work in the field, and I consider it a fortunate decision. I find working in the field interesting specifically for its constant rapid development, where it is necessary to be prepared for change every year and learn new things.

SIGNIFICANT MILESTONES
AND RESULTS OF CZECHGLOBE

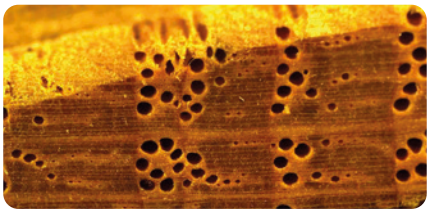
10 YEARS CzechGlobe

Construction of the Atmospheric Station Křešín near Pacov

One of the first and very „visible“ achievements in the history of CzechGlobe was the construction of the Atmospheric Station in Křešín near Pacov. The station was commissioned in 2013 and its main part is a two hundred and fifty meter high anchored measuring mast. The mast is the tallest structure built in the Czech Republic after 1989 and also the tallest structure which has ever been built for scientific purposes. The station serves as a national monitoring point for the occurrence and long-range transport of greenhouse gases, and in addition to greenhouse gases such as CO_2, CH_4, CO, N_2O and SF_6, selected pollutants and basic meteorological characteristics are monitored here at several elevations above ground level. The atmospheric station is part of the network of stations within the pan-European research infrastructure ICOS (greenhouse gas monitoring) and the ACTRIS network (aerosol monitoring). Together with the Košetice Observatory of the Czech Hydrometeorological Institute and other infrastructure, it forms the National Atmospheric Observatory.



The agricultural drought between 2015-2018 surpassed all dry periods in the last two millennia



The uniqueness of CzechGlobe lies in its interdisciplinarity and its comprehensive approach to problem solving, with strong collaboration between different scientific teams. An exemplary result of such collaboration is the 2021 publication by an international team of scientists in the journal *Nature Geoscience* “Recent European drought extremes beyond Common Era background variability”, which was produced under the leadership of Professor Ulf Büntgen working at the University of Cambridge and CzechGlobe. CzechGlobe experts in bioclimatology, historical climatology, isotope analysis, plant ecophysiology and dendrochronology all contributed to the publication.

The study focused on the reconstruction of the past climate by analyzing stable isotopes of carbon and oxygen in oak rings, mainly from the Czech Republic. The researchers focused on the summer climate and especially the occurrence of the so-called agricultural drought over the past 2110 years. Unlike most similar studies, they obtained precisely dated information for each year on the degree of moisture deficiency or, conversely, excess moisture. The study revealed that the long-term trend of drying out of the landscape evident throughout the period under review accelerated significantly during the 20th century, and after 2015 eventually surpassed all previous dry periods. The summer agricultural droughts, which have affected particularly Central Europe in recent years, have been more severe than any other drought periods in the past 2110 years, roughly since the time of Julius Caesar.

Assessment of the impacts of climate change on future wheat production

Climate change can also affect food production through drought. In terms of cultivation area and production, wheat is the most frequently grown crop in the world. Wheat is also the most important traded cereal, making it a key crop that compensates for fluctuations in food production between regions of the world. In 2019, an international team of scientists led by Professor Trnka from CzechGlobe published in the journal *Science Advances* a study entitled “Mitigation efforts will not fully alleviate the increase in water scarcity occurrence probability in wheat-producing areas “, which analyzed 27 climate models (each with three different scenarios) using computer capacity in the USA to look at how drought affects wheat production and its price. The study revealed that, unless action is taken to mitigate climate change, up to 60 percent of current wheat-growing areas worldwide could face drought episodes affecting several wheat-producing regions simultaneously by the end of the century. This is four times the risk that scientists currently observe, and it has clearly already had and continues to have a significant impact on key areas responsible for global wheat production.

If only one country or production region is facing drought at any given time, the negative impact is usually offset by production from other regions. However, if more than one region is affected at the same time, as the study suggests is a real possibility, global production is very likely to be negatively affected. Experience has shown that if such an episode occurs and inappropriate trade restrictive measures are chosen, drought can have a significant impact on food prices, leading to increased market volatility and, in some particularly vulnerable regions, a significant deterioration in food availability.

ANTARCTICA RISKS RAPID AND IRREVERSIBLE MELTING IF WARMING RISES ABOVE 2°C

GOT OUR ATTENTION

In 2015, world's governments pledged to take measures to keep the global temperature growth between 1.5 and 2°C compared to the pre-industrial period. However, current government commitments would mean a warming of up to about 3°C. According to a new study published in the journal *Nature*, approaching this warming limit would mean a significantly greater risk of a rapid and irreversible rise in world ocean level associated with the melt of Antarctica already before the end of this century.

Along with the increasing knowledge about the physical processes associated with ice melt, there are more and more forecasts of a gradual rise in global ocean level due to the amplification of the greenhouse effect of the atmosphere.

In their new model prognosis, an international team of scientists led by Robert DeConto of the University of Massachusetts in the USA also took into account how the melting rate of marginal ice-sheets and associated instability is affected by the loss of ice shelves (land-based ice masses floating on the ocean surface).

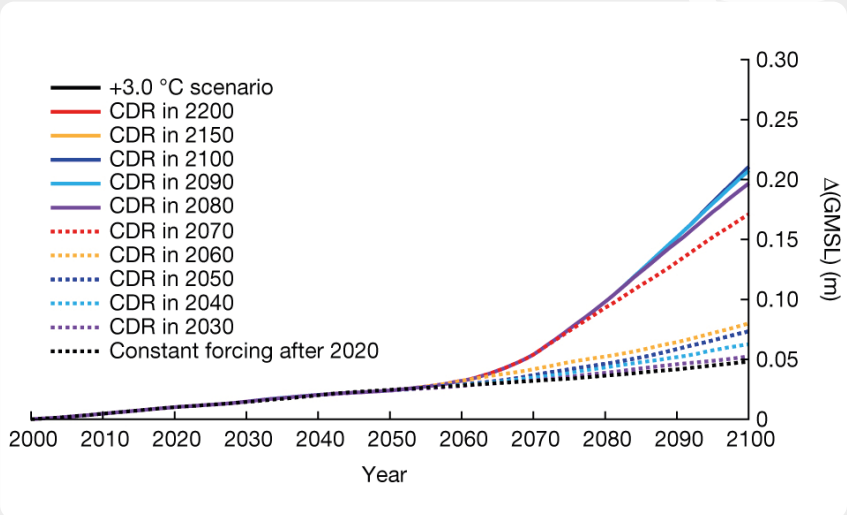


Fig. 1: *Projections of global ocean level rise due to the melt of Antarctica by 2100 according to a range of different scenarios: emission scenario of 3°C warming (black line, merging with blue lines), then scenarios following this 3°C warming trajectory, from which it deviates in a certain year (2030, 2040, etc.) and returns to the pre-industrial levels within a century and finally the emission scenario of constant radiative forcing after 2020 (black dashed line).*

The results of the study suggest that if existing emission reduction commitments were met but not tightened, Antarctica would contribute to an increase in ocean level by more than 20 cm, and ocean level would continue to rise beyond 2050. In addition, after 2070, there would be an acceleration of the trend, which could no longer be reversed by a subsequent reduction in emissions. All projections indicate that the sea level increase caused by the melt of Antarctica will continue at least until 2050. The presented model also demonstrates the existence of an ice melt tipping point at warming above 2°C.

Another study on the subject, published in the same issue of *Nature*, was led by Tamsin Edwards of Kings College, London. The study shows that if the temperature rise were kept to 1.5°C, the rise in ocean level this century would be only half as much as if the temperature rise continued. The study involved 84 scientists from 15 countries, and its results are based on nine hundred simulations of ice-melt models. The results of both mentioned studies show the need for adaptation of coastal areas even in the case of optimistic emission scenarios. If global temperatures continue to rise, it is necessary to prepare for the inevitable huge economic damage. -aa-

References:
DeConto R.M. et al., 2021, Nature: https://www.nature.com/articles/s41586-021-03427-0
Edwards T.L. et al., 2021, Nature: https://www.nature.com/articles/s41586-021-03302-y

WHAT´S NEW

Bioeconomy and Circular Economy Conference

March 16, 2021 – GCRI together with the South Bohemian Agency for Support to Innovative Enterprising and the Institute of Circular Economy organized an online international conference Bioeconomy and Circular Economy. The conference presented the current state and trends in the field of bioeconomy and circular economy in the Czech Republic and Central Europe, as well as key documents on the topic, their implementation in the Czech Republic and the pitfalls of the post-covid period. There was also a moderated panel discussion. The conference was attended by 180 participants from Central Europe, Slovenia, Germany, Switzerland and France.

Forum Carpaticum 2021 Conference

June 21 – 25, 2021 - GCRI together with the Faculty of Forestry of Mendel University organized an online international scientific conference 6th Forum Carpaticum. Forum Carpaticum is an open meeting of the Science for the Carpathians initiative (SC4). S4C brings together researchers in Central Europe and defines research priorities for the region, provides applicable knowledge for regional policy and strengthens international cooperation with partners outside the Carpathian region. The conference focused on the results of research in the fields of climate, water, ecological nature protection processes and sustainable use of natural resources in the context of the Carpathian region. It also aimed at strengthening interdisciplinary and intersectoral cooperation between scientists, policy makers and practitioners. The conference was attended by more than 150 participants from Europe, the USA and Australia.

Professor Trnka a guest of Science Café

June 22, 2021 - prof. Trnka from CzechGlobe was an online guest of the talk show Science Café, organized by the Czech Center in Brussels and the Embassy of the Czech Republic in Brussels. The topic of the discussion was extreme drought and its effects. In this context, the dialogue focused, for example, on the INTERSUCHO portal, the experience of partners with a similar portal in the USA, the effects of drought on agriculture, food security and forest dieback.

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