Newsletter
1/2015

CzechGlobe
Global Change Research Centre CAS, v. v. i.

EVENTS OF THIS SPRING – BUILDING ENLARGEMENT, EVALUATION AND EXPO

This time last year our Newsletter informed you of the Grand opening of the CzechGlobe Centre, which related mainly to the opening of a new laboratory pavilion. A year has passed by and now, at the place where we were celebrating in party tents, construction machinery is raging. However, it is not because CzechGlobe has significantly expanded, but rather a consequence of the fact, that six years ago, when the project of the Centre was created, we had no idea that so many job positions for administrative and technical staff will be brought about by the newly created jobs for researchers.

At the beginning of the year we learned the results from the international evaluation of the CzechGlobe project. The results could not have been better. Perhaps, for us, it was a successful rehearsal before the regular five-year international evaluation of the institutes of the Academy of Sciences. The evaluation takes up practically the whole year. Since the very beginning of the Centre, all the evaluated teams – there are six of them within GCRC – in several stages have had to present the reports and results of their scientific activities between 2010 and 2014. These reports are now in the hands of the members of the international evaluation panels. Another stage in the evaluation, for which the entire autumn has been reserved, will be the visit of the evaluators to the scientific teams. Thus we won't get the final verdict until the beginning of next year.

After we had renounced our participation in the World EXPO 2015 in Milan due to high financial costs, we got another offer in the spring. This time it was from the South Moravian Region, to introduce ourselves at the EXPO within the 14-day-long presentation of the region. Thanks to our presentation, visitors to EXPO could understand once again that all food production, which was a topic this year's EXPO revolved around, primarily depends on photosynthesis. The display was based on the research on the photosynthesis of terrestrial ecosystems and on the utilization of the potential of algae photosynthesis in biotechnologies. The presentation was carried out through a film loop and an interactive model of a bioreactor for mass cultivation of selected species of algae.

From the topical point of view, our presentations completely reflected the EXPO slogan „Food for the Planet, Energy for Life" while conveniently fit into the overall concept of the Czech national pavilion, which, as one of the few, focused on the presentation of significant scientific discoveries. And perhaps that is why the Czech pavilion ended up on the 2nd place according to the visitors' evaluation. Just after the pavilion of the hosting country Italy.

After the Olympics in London in 2012, CzechGlobe, in a relatively short time of its existence, got another opportunity to be seen at an event that the whole world watches. In this respect CzechGlobe made at least a small contribution to the presentation of the whole Czech Republic at the world exposition. It's great that these massive events – after all EXPO aspires to attract 20 million visitors – make it possible to bring scientists and science closer to the broad masses of people.

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WE ARE INTRODUCING THE DEPARTMENT OF MATTER AND ENERGY FLUXES

WE KEEP OUR FINGER ON THE PULSE OF THE ECOSYSTEM

says Marian Pavelka

He has been working for the Global Change Research Centre AS CR since 1991. He started as a research technician. In 2003, he graduated from the Faculty of Science at Palacky University in Olomouc in the degree course called Environmental Protection and Creation. Then he completed his doctoral studies in Applied and Landscape Ecology at the Faculty of Agronomy, Mendel University in Brno. Since 2010, he has been the head of the Department of Matter and Energy Fluxes. Within the department he is engaged in the research on carbon fluxes between ecosystems and the atmosphere and also in technical development of measurement systems.

Your department is concerned with the fluxes of matter and energy. How can it be explained in layman's terms?

In our research we focus on measuring the fluxes of greenhouse gases (CO_2, CH_4, N_2O and water vapor) between the atmosphere and the studied ecosystems. In ecosystems, these gases are involved in physiological processes of photosynthesis, respiration, denitrification and evapotranspiration. We are looking for controlling factors that affect these fluxes, we are looking for relationships between meteorological elements and current fluxes of gases. These relationships are then mathematically formulated and consequently we create mathematical models of the behavior of ecosystems in terms of both the current and the future changed climate.

How are such measurements carried out?

In our research, we are interested in terrestrial ecosystems where we place our ecosystem stations. We already have a whole network of them. They cover most types of ecosystems in the Czech Republic: young spruce forest at Bílý Kříž in the Moravian-Silesian Beskydy Mts. , mature spruce forest near Rájec Jestřebí in the Drahany Highlands, beech forest in Štítné nad Vláří in the White Carpathians, floodplain forest near Lanžhot in South Moravia, mountain meadow at Bílý Kříž, agroecosystem, i.e. a field used for agricultural production, near Křešín at Pacov in the Bohemian-Moravian Highlands, wetland near Třeboň in South Bohemia, and in collaboration with colleagues from the Department of Climate Change Impacts on Agroecosystems, a station located in the poplar plantation in Domanínek in Bohemian-Moravian Highlands. Each station is equipped with the so-called eddy-covariance system attached to a meteorological mast over the studied ecosystem. Eddy-covariance system, through very precise and rapid measurement of the concentration of greenhouse gases and turbulent airflow, is able to calculate the fluxes of the mentioned gases between the studied ecosystem and the atmosphere. For example, in the case of CO_2 the system using the input data on concentrations and air movement measured in all three spatial axes 20 times per second, calculates for every half hour how much carbon dioxide has been accepted by the ecosystem, if photosynthesis prevailed, or how much it has released, if respiration prevailed. So we have the data for every half hour, every day, all year round since the opening of all the ecosystem stations. Simultaneously, we measure a number of other parameters that are essential for our analyses, primarily we carry out continuous measurement of values of basic meteorological parameters - the incident solar radiation, radiation balance, the amount of solar radiation passing through the stand, temperatures and relative air humidity, temperatures and soil moisture, the heat flux into and out of the soil, the total atmospheric precipitation and other elements.

One of the great advantages of eddy-covariance method is that it needs only one measuring point, which is the mast above the stand, to measure the fluxes of greenhouse gases in areas from square hectares up to square kilometers with almost no effect on the studied ecosystem. However, this method is unable to distinguish each specific sources or sinks of carbon dioxide, namely individual plants, soil with roots, stems, branches and foliage.

And can these sources or sinks be identified in any other way?

Certainly. To measure the fluxes of CO_2, CH_4 and newly also N_2O, we use auxiliary measuring chamber systems which have the capability to measure at the level of individual components of the ecosystem. We also use commercial systems for manual campaign measurements, but for long-term continuous measurements we have systems that were developed at our department according to our specific needs and particularities of individual ecosystems. We also work with other CzechGlobe teams who share the results of their measurements with us, such as photosynthesis rate at the level of a leaf or a shoot (Laboratory of Ecological Plant Physiology), the amount of water passed through the stem and therefore transpired by the given tree into the atmosphere, and information from periodic inventories of forest stand biomass (Department of Water Operation and the Creation and Allocation of Biomass). We also use the data from our colleagues working at the Department of Remote Sensing who are operating an airborne laboratory, i.e. an aircraft equipped with a hyperspectral camera and other sophisticated sensors. The above mentioned data allows us to transfer the results obtained in specific locations to a higher spatial level, i.e. the level of the Czech Republic or even Central Europe.

From what you say, I assume that your team consists primarily of physicists.

With respect to the complexity of the methodology we use, our team is quite varied. From personnel in technical positions responsible for the operation of measurement systems and primary data processing, through postgraduates, who include, inter alia, a mathematician and statistician, to proficient researchers with predominantly biological education (forest engineering, ecology, biology), but also a chemist and, last but not least, an atmospheric physicist. Finding a suitable candidate for such a job position is not always easy and, for example, our new colleague comes from far Australia. I think our current team has successfully been built so that its members cover the whole long chain of necessary actions and activities, from the operation of the measuring devices in the field, through data processing, analyses and modeling, to writing publications. In addition to that, we also design some measurement systems and we participate in their development and production.

What specific information can you gain from the interpretation of your results, then?

We like to say that thanks to the comprehensive line-up of used devices „we keep our finger on the pulse of the ecosystem." We are able to say how much of the given greenhouse gas the studied ecosystem has bound, or released for every half hour throughout the year, and under what conditions it occurred. We can determine to what extent the basic components (soil, aboveground biomass, or possibly its individual components: stems, branches, foliage) are involved in the total flux. We can calculate the ecosystem's greenhouse gas balance for different time periods from days to years. To get a better idea, for example, a hectare of our young spruce forest at the Bílý Kříž station will bind

and store in its biomass and soil in a year as much CO_2 as it is produced by a passenger car while driving a distance approximately equal to 3.4 times the way around the equator. In contrast, a mountain meadow holds almost no CO_2, because almost everything that is bound in the process of photosynthesis is in the process of respiration breathed away. From our measurements we also know how much water was released from the ecosystem by evapotranspiration in the form of vapor and what was its cooling effect thanks to the phase change from liquid water to water vapor. So again, to get a better idea, in the case of a young spruce forest, it is as if there were two and a half refrigerators on every square meter. And finally, through models that were constructed thanks to the obtained data and using outputs from other CzechGlobe teams concerned with climate modeling, we can predict the future behavior of ecosystems in terms of the changed climate.

Are the results of your research also practically usable?

Of course, they are. Our results help us make recommendations on how to manage the different types of ecosystems in several respects. Not only in terms of their possible survival, in terms of maximum production but also, last but not least, in terms of their ability to bind carbon dioxide from the atmosphere, thus slowing down the increase of its concentration in the atmosphere, and thus moderating the climate change.

Are there any other departments in the Czech Republic that are engaged in this issue?

In the Czech Republic, we are the only ones who operate a network of ecosystem stations for the comprehensive measurement of matter and energy fluxes as well as other supporting measurements. However, we are by no means isolated. Our department, together with the Department of Atmospheric Matter Fluxes and Long-range Transport, is part of the international European project called Integrated Carbon Observation System (ICOS) and CzechGlobe is its founding member. The Czech Republic is thus one of only two post-communist countries involved in the most important European project dealing with the research in greenhouse gases. Yet, we are not playing „second fiddle“ in this project, on the contrary, we participate very actively in the development of common methodologies. Thanks to our extensive experience with the design and operation of chamber systems used for the measurement of greenhouse gases fluxes, we, together with a colleague from our department, Manuel Acosta, were appointed within the ICOS network the heads of the Working group for chamber measurements. I'm also a vice president of the Monitoring System Assembly, i.e. a gathering of representatives for ecosystem stations. Our ecosystem station at Bílý Kříž became one of four ICOS demonstration stations. On the other hand, we are also developing cooperation outside the ICOS project, we have established collaboration with major European and non-European departments, for example, The National Ecological Observatory Network (NEON, USA).

DEPARTMENT OF MATTER AND ENERGY FLUXES

In terms of the structure of the CzechGlobe Centre, the Department of Matter and Energy Fluxes is incorporated in the Section of Systems Analyses.

It mainly deals with the studies of fluxes of main greenhouse gases between ecosystems and the atmosphere. It investigates the factors affecting these flows, and thus the production activity of selected terrestrial ecosystems. The department translates the data obtained from measurements at different ecosystems stations into the scale of the whole Czech Republic and models the estimates of the future development of ecosystems and their ability to bind atmospheric carbon, both under the current conditions as well as under the conditions of expected global climate change.

The Department of Matter and Energy Fluxes is one of the institute's largest departments, which is due to the extensive research infrastructure deployed across the Czech Republic so that it covers basic types of ecosystems. At present, the department employs ten researchers, seven PhD students and three technicians, including seven foreign workers.

Since the 5th Framework Programme, the department has been a regular partner in major European projects dealing with the study of the carbon cycle and greenhouse gas monitoring. At present, it is a founding member of a project of the European research infrastructure ICOS, which was established within the 7th Framework Programme and the ESFRI programme. An ICOS complement in terms of the Czech Republic is a project of the national infrastructure called CzeCOS. Within CzechGlobe, the Department of Matter and Energy Fluxes plays a very important role in CzeCOS solution.

4TH CZECHGLOBE ANNUAL CONFERENCE

On the 23rd and 24th March 2015 GCRC organized already the fourth Annual Conference of the CzechGlobe Centre. The international conference entitled „Global Change: A Complex Challenge“, supported by the ECOP project called „ENVIMET“, was held in the new science amusement park VIDA! Science Centre in Brno. The aim of the conference was primarily the presentation of the work and results of young scientists and PhD students of the Centre, both through lectures and poster presentations. Within each thematic section, speakers from the ranks of international experts were also invited. Let's name at least one of them - Professor John Grace from the University of Edinburgh. In his introductory lecture, he comprehensively summarized the human influence on the climate system. The event, with nearly 140 participants, showed that the CzechGlobe Centre with the level of its research can already be compared with reputable foreign institutions. This was proved by the fact that the results presented were the direct outcome of foreign cooperation, or that the skills showed were skills that our employees had learned abroad. As in previous years, also this year, concurrently with the CzechGlobe Annual Conference, the Centre held a meeting of its International Advisory Board which was associated with the Centre's evaluation.

GOT OUR ATTENTION

ANTHROPOGENIC CONTRIBUTION TO THE OCCURRENCE OF WEATHER EXTREMES

Erich M Fischer, Reto Knutti

The relationship between the global change and extreme weather is complicated. It is recognized that the increase in temperatures will lead to an increase in the likelihood of extremely high temperatures, heat waves or extreme precipitation. On the other hand, specific weather incidences cannot be attributed solely to the impacts of enhanced greenhouse effect. Scientists from the Swiss Institute for Atmospheric and Climate Research in Zurich focused on a more detailed description of the relationship between warming and extreme weather.

The fact that higher average temperatures lead to warmer days, and warmer air is able to retain more water vapor, which must be precipitated somewhere, has been known for a long time. Also, several previous studies had addressed the attribution of individual weather extremes to the global change on a given territory. So far, however, it has not been clear to what extent the observed extremes are directly the result of warming, and how the changes take place globally. According to the analysis results, up to 75% of extremely hot days and 18% of extreme rainfall can now be explained just by the gradual warming since the beginning of the industrial revolution. The work also shows that the more extreme weather conditions, the higher the proportion of the impacts of warming. In the case of temperatures, the increase in the human influence is exponential. Also, the longer the given extreme lasts the higher the proportion of human effect on it (Fig. 1).

The scientists used climate models to compare the probabilities of exceeding a certain critical threshold of temperature or rainfall intensity, namely in the period before the industrial revolution and today. The difference in the observed probabilities is then the consequence of the global change. If, in the past, a certain temperature was exceeded once every three years, now this happens in less than a year, with two of the three events being the result of warming. The scientists compare the situation to smoking cigarettes. In some instances, one may be lucky and the precise cause of death is uncertain, on the other hand smoking increases the risk of cancer and certain proportion of deaths can be attributed to smoking.

As the international community seeks to limit warming to 2°C, the researchers analyzed also this scenario. With such warming the probability of reaching extreme temperatures is nearly twice as high as in the case of warming of 1.5 °C, and up to 5 times as high compared to today. This is very significant because even a relatively small increase in the resulting global warming represents a major increase in the incidence of extremes. With the temperature increase of 2°C virtually all extreme temperatures and up to 40% of extreme precipitation will be a result of increased global temperature. This study is also significant in that it provides the first global view of the occurrence of extremes and their risks. The most striking increase in risk can be expected in tropical areas and islands, where the ability to face these extremes is usually low. The next step in the field of scientific research is to separate natural factors affecting the occurrence of extremes (such as solar activity) from anthropogenic factors.

Link: http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate2617.html **-aa-**

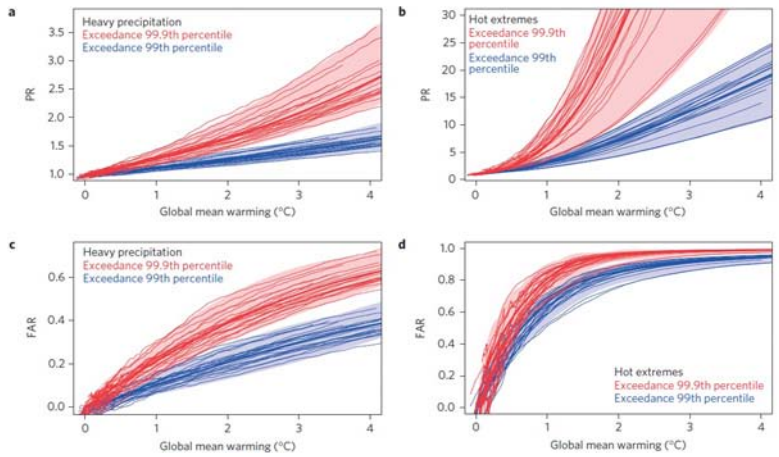

Fig. 1 .: *The upper graphs show the probability ratio of exceeding the (blue) 99th and (red) 99.9th percentile in the case of temperatures (a) and precipitation (b) on the continents before the industrial revolution for a certain level of global warming (x-axis). The lower graphs show the share of temperature (c) and precipitation (d) events for the given percentiles. This share can be attributed to warming.*

WHAT´S NEW

The Czech Senate on the issue of drought

On 2nd February 2015, a conference called „The benefits of the integrated drought monitoring system" was held in the Senate of the CR. It was organized under the auspices of the President of the Committee on National Economy, Agriculture and Transport of the Senate of the CR, Jan Hajda. Among the main speakers who presented their contributions were the employees of the GCRC namely from the Department of Climate Change Impacts on Agroecosystems. They have been engaged in the issue of drought for a long time and in this respect they are considered recognized experts not only in the Czech Republic.

Training school of scientific publishing and writing

From 2nd to 4th February 2015, within the ECOP project called „ENVIMET" under the guidance of experienced lecturers - Professor Ceulemans (University of Antwerp) and Professor Linder (Swedish University of Agricultural Sciences in Uppsala) a "Training school of scientific publishing and writing" was held in the premises of the GCRC. The course was primarily intended for PhD students and young researchers engaged in plant biology.

Meeting of the representatives of Marie Curie Alumni Association

On 17th April 2015 GCRC hosted an international meeting of the representatives of the Marie Curie Alumni Association (MCAA) that brings together alumni from internships in programmes of EC Marie Curie Actions supporting the mobility of scientists. The objective of the meeting with more than 30 participants was to present the activities of the Association to potential new members and to prepare the establishment of Czech chapter within the MCAA. This section will be supposed to bring together Czech alumni of the programme, to promote their cooperation, meetings and activities associated with the promotion of the Association as well as the Marie Curie Programme itself.

French Ambassador visited the Atmospheric station

On 18th May 2015 French Ambassador, Jean-Pierre Asvazadourian, visited the Atmospheric station in Křešín near Pacov. Besides the discussion on the share of the GCRC in Czech-French cooperation in the research on the atmosphere, the debate concerned the agenda of the upcoming UN International Conference on Climate Change, which will be hosted by the French government from 30th November to 11th December in Paris this year.

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