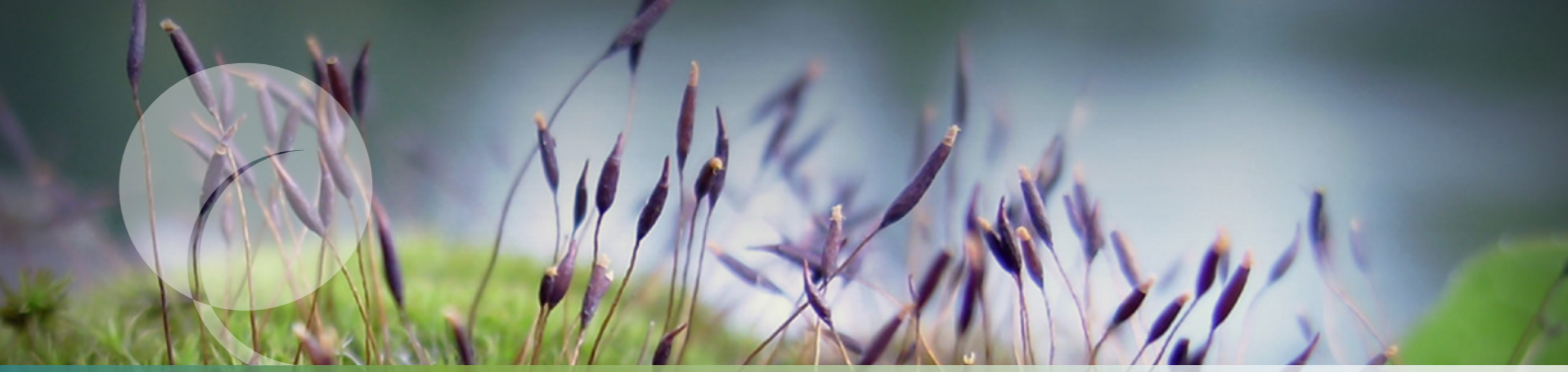


Newsletter

1/2023

CzechGlobe

Global Change Research Institute CAS

WE SCORE BOTH IN INTERNATIONAL PROJECTS AND INDIVIDUALLY

This year, CzechGlobe marks several important milestones. Above all, it has been 35 years since ecophysiological research was launched at the Bílý Kříž experimental station, which can rightly be considered the place "where it all began". And although it doesn't seem like it, 10 years have passed since the opening of the Atmospheric Station in Křešín near Pacov and the Ecophysiological Research Station in Domanínek.

During that time, the stations, which are the imaginary showcase of CzechGlobe, have significantly contributed and helped to obtain many unique results. Time and progress move on and we don't rest on our laurels either. That is why our stations continue to develop and measurements and research activities continue to increase. By way of example, we can mention the infrared and microwave scintillometer in Křešín for monitoring water vapor fluxes in the Švihov water reservoir basin, the network of dendrometers at Bílý Kříž and throughout the country, or the new growth chambers in Domanínek, which are currently being completed, for experiments with agricultural crops in elevated CO2. These are replacing 10-year-old chambers, which have already reached the end of their lifespan due to the great contribution of windstorms. The purchase of new modern devices as well as the maintenance of existing ones is very financially demanding. Therefore, the question logically arises as to how we will be able to maintain and modernize the infrastructure in the future, if the latest proposal of the Ministry of Finance to cut spending on science and research by 10% as part of the 2024 national budget cuts passes… It is in our vital interest to communicate our activities, results and practical outcomes to as wide a public as possible, either directly, e.g. at open days, or through the media, for which we have organized a series of informal meetings.

The fact that CzechGlobe is a good environment for quality research and a beneficial partner for cooperation has been demonstrated several times this year. Our nominee, a member of the international Scientific Advisory and Ethics Board (SAEB) of CzechGlobe and our long-time collaborator, prof. Christian Körner received the Gregor Johann Mendel Honorary Medal for Merit and our postdoctoral fellow Stanislav Juráň received the Otto Wichterle Award. We cover both awardees in more detail in the Newsletter. In mid-May, the SAEB CzechGlobe met. Since 2012 it has been chaired by prof. Sune Linder, who celebrated his 80th birthday in the spring. On the occasion of this important life jubilee, he received the CzechGlobe commemorative medal from the Director of the GCRI, Michal Marek, and at the same time he passed the imaginary scepter of the SAEB chairman to prof. Reinhard Ceulemans.

Since the beginning of the year, our scientists have started solving three large international projects. First of all, it is the PLUS Change project of the HORIZON EUROPE programme aimed at creating strategies for the transition to climate-neutral land use. It is particularly rewarding that the project coordinator is Julia Leventon from CzechGlobe. It is a great experience for the Institute to coordinate such a project and at the same time a great opportunity as well as prestige. The second project, again from HEU, is BENCHMARKS which monitors soil health across Europe, and the third is the Clim4Cast project, supported by the Interreg CE programme, which is supposed to contribute to improving the forecasting of extreme meteorological phenomena, mainly droughts, heat waves and fires that are the most common in the CE region, through a newly developed online mapping application.

When recapitulating important events, we must not forget the completion and opening of the ecosystem station in Ghana, which is proof that CzechGlobe is raising its profile abroad. It is appropriate to say that our technicians, who prepared the station's equipment in the Czech Republic and installed it and put it into operation in Ghana under difficult conditions, have a large share in this. Technicians are something like family silver for us, and it is good that the Academy of Sciences also thinks of this professional staff and awards a Certificate of Appreciation to selected individuals. This year it was also awarded to our technician Karel Staník, who has been working for us for 22 years and mainly takes care of equipment for eddy covariance measurements on the towers of ecosystem stations.

That's the end of the list of positive news, and now on a completely different note. This is also part of our work. According to climatologists, we are in for another hot summer linked to a strong El Niño phenomenon on the way. As the Czech Republic, we have been relatively well this year in terms of weather. The winter wasn't extreme, but it got pretty bad in the world. The southern parts of the Alps experienced a winter with little precipitation, and the lack of snow contributed to the persistent drought in Italy and France. The drought under the Alps threatened not only farmers, but also the operation of hydroelectric power plants, before it was cut short in Italy in mid-May by repeated flooding, as is usually the case. Spain has been experiencing scorching heat since the spring months and a long-term record-breaking drought, where 80% of the territory is affected by drought. It is not only farmers and livestock farmers who are running out of water, but also people.

California has been plagued several times since autumn by a phenomenon called an atmospheric river, characterized by prolonged, intense rainfall. The result was devastating flooding and landslides. The world is currently watching the giant forest fires in Canada, the smoke of which threatens even the residents of major cities such as Toronto or New York.

We wish you a nice summer without any extreme phenomena and that the warning predictions of climatologists do not come true.

-mš-

Meet one of us

Ing. Stanislav Juráň, Ph.D

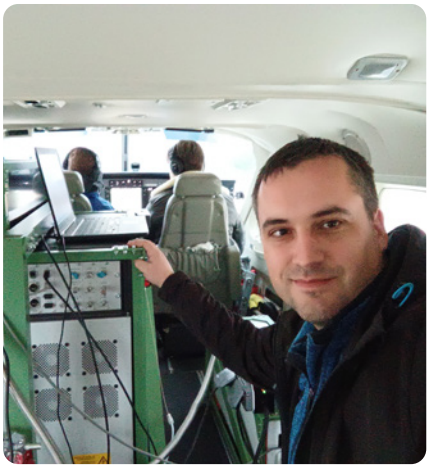
He is a recent recipient of several awards – the Otto Wichterle Award, which is awarded annually by the Czech Academy of Sciences to the best scientists under the age of 35, the Atmosphere 2022 Outstanding Reviewer Award and, together with colleagues Otmar Urban and John Grace, also the Atmosphere 2021 Best paper Award.
Stanislav Juráň was born in Brno. He graduated in Molecular Biology and Genetics at Masaryk University and continued to study Plant Biotechnology at Mendel University. Here he also completed his doctoral studies in Anatomy and Physiology of Plants. During his PhD studies he started working at CzechGlobe and soon went to Rome for a six-month internship, where he gained experience that taught him how to install ozone fluxes measurements and their modeling. After completing his PhD, he went to Austria's Innsbruck for half a year, where he was involved in the measurement and modeling of volatile organic compounds. At CzechGlobe, he pursues the measurement and modeling of ground-level ozone fluxes and its effect on vegetation and volatile organic compounds in ecosystems, their role and relationship in the ecosystem-atmosphere continuum. He is married, raising two children and in his spare time he usually stands at a cement mixer or explores caves.

Professionally, your main focus is on emissions of volatile organic compounds. Where do they come from in nature, what affects their emissions and what is their significance?
Volatile organic compounds are both produced by human activities, such as burning fossil fuels or using solvents and detergents, and by plants. Accordingly, they are divided into compounds of anthropogenic and biogenic origin. If we focus on natural volatile organic compounds (whose total emissions amount to 760 Tg (C) per year), most of these compounds worldwide are represented by isoprene (70%), monoterpenes (11%), methanol (6%), acetone (3%), sesquiterpenes (2.5%) and other substances such as their oxidation products (2.5%). A special group is the volatile plant hormones. Emissions are significantly affected, for example, by temperature, this applies to monoterpenes, and by temperature and light which applies to isoprene. The emissions of these substances can be said to increase exponentially with increasing plant stress, e.g. drought or high temperature. The reasons why they are produced by plants, however, are still not entirely clear. Some of these substances act as protection against predation or as pollinator attractants. Some have the function of hormones, for example methyl salicylate and methyl jasmonate.
For example, isoprene, which represents the largest emission, was thought to act as a stabilizing element in the cell membrane, helping to maintain its strength at elevated temperatures. However, later it turned out that there are too few of these molecules to really work this way. One of the earlier explanations for the natural emission of volatiles was that it is a release of energy at a time when photosynthesis is suppressed at high temperatures. While this is partially true, it costs the plant too many resources to reliably explain the phenomenon. Another more recent explanation is that plants protect themselves from phytotoxic ground-level ozone by a layer of volatile compounds above the leaf. Ozone reacts with them, and thus has no chance to reach the stomata, where it would damage the lipids. That's how it really works, nevertheless before the industrial revolution there was very little ozone in the air, so plants didn't need to defend themselves in this way, and yet they were already producing volatile compounds. So we still don't quite know the answer to the notional "why" yet.

Do volatiles contribute to climate change? Do they have a similar effect to greenhouse gases, for example?
Volatile organic compounds contribute both negatively and positively to climate change. On the one hand, they contribute to the formation of ground-level ozone, which is a greenhouse gas, but at the same time, their gradual oxidation leads to the formation of a secondary organic aerosol, which dampens the impact of radiation on the surface by absorbing it. Their role is therefore twofold.

You are a pioneer when it comes to solving the issue of volatile compounds in CzechGlobe. How and where did you start measuring them?
In 2014, I went on a six-month internship with Silvan Fares at the Research Centre for the Study of Plant-Soil Relations (CREA - RPS), where they had extensive experience in measuring volatiles. In Italy, near Rome, I took part in several measurement campaigns in forest stands, where the dominant tree species is holly oak. It is atypical in that it produces both isoprene and monoterpenes. Here I learned the eddy covariance technique using a PTR-MS instrument. At that time, I also took with me a fast ozone analyzer, which we put into operation there, and later I installed it on the tower of our ecosystem station at Bílí Kříž, where it still measures ozone fluxes using the eddy covariance technique. I chose Italy not only because of the suitable institution, but also for its Mediterranean climate, where due to higher temperatures there are large emissions of volatile compounds and, by our standards, high concentrations of ground-level ozone. I later used the experience I gained when installing the measurements of ozone fluxes at our atmospheric station in Košetice, and I also measure the fluxes of volatile compounds regularly every year during measurement campaigns at various locations.

Is it different to measure emissions of volatile compounds in the Mediterranean and in our latitudes (e.g. at Bílý Kříž)?
The big difference in measurements in our country compared to Italy is mainly the winter season, when the vegetation there still



shows emissions, whereas here there are none. Another difference and challenge is the frost and the associated freezing of the anemometer, which means more gaps in the measured data.

You have already mentioned the connection between volatile compounds and the formation of ground-level ozone. What about its harmfulness to vegetation, the environment and the human body?

Ground-level (tropospheric) ozone causes enormous economic losses in wood and grain production. It damages the photosynthetic apparatus and thus reduces the output of photosynthesis. Although plants have various robust detoxification mechanisms, if the flux of ozone into the stomata is too high, they are unable to remove all the ozone and damage occurs. Of the volatile compounds, mainly isoprene, but also monoterpenes and other substances are involved in the formation of ozone. They catalyze a photochemical reaction in the presence of nitrogen oxides. These are mainly produced during the combustion of fossil fuels. It is therefore not plants that are responsible for the formation of ground-level ozone, but rather people, thanks to the emissions of nitrogen oxides. Rain forests are proof of this. In places where there is no deforestation and burning, there are huge concentrations of volatile compounds, but no nitrogen oxides. Therefore, ground-level ozone is not produced there. In addition to affecting plants, ozone also has a negative effect on the health of the population. It is part of smog, both summer and typically winter smog. Ground-level ozone is a cause of respiratory diseases and premature deaths.

Can anything be done about high ozone concentrations?

Many countries are trying to reduce ozone concentrations, but so far they have not been very successful. This is because there must be a drastic reduction in the concentration of nitrogen oxides or a reduction in emissions of volatile compounds. Some results can be achieved through appropriate tree planting, where species with lower emission potential are preferred. However, it always depends on the location, if ozone formation is limited by nitrogen oxides or volatile compounds.

OPENING MEETING OF THE PLUS CHANGE PROJECT IN PRAGUE

On the 12th - 14th June 2023 at the Technology Center in Prague, the Global Change Research Institute of the Czech Academy of Sciences held a three-day introductory kick-off meeting of the consortium of the international project Planning Land Use Strategies: Meeting biodiversity, climate and social objectives in a changing world (PLUS Change. The Plus Change project is a new four-year project of the Horizon Europe programme coordinated by prof. Julie Leventon of GCRI – CzechGlobe, for which this is a significant opportunity to coordinate a framework programme project with a wide range of partners. The project aims to achieve a change in land use so that it is climate neutral, resilient and biologically diverse. At the same time, these changes must contribute to securing the production of food and non-food commodities and support socio-economic development changes requiring changes in behavior and decision-making. Such an ambitious comprehensive approach to the issue of land use change also reflects the composition of the project consortium, which requires linking expertise from the social sciences, humanities and arts with land use models and their integration using systemic methods. The consortium thus consists of 23 institutions from 14 European countries and includes universities, research organizations, representatives of regional institutions for strategic planning and land management, as well as an art agency.

The opening meeting was attended by fifty of their representatives, who presented their individual teams, more coherent working groups and work packages. The representatives of the institutions responsible for the individual work packages presented the steps that will lead to the achievement of the planned outcomes of the project. Adequate time was devoted to partners from the regions, who come from different backgrounds and whose expectations and needs differ in many aspects. At the same time, however, they were these regional institutions that prepared case studies representing territorial units (counties, regions or protected areas) with different dominant ways of land use – from urban, suburban to rural areas, on the basis of which the project is anchored and integrated. These locations will be used for meetings and surveys with stakeholder groups and at the same time they will be used for pilot testing of project outputs in order to fulfill the project's goal of developing sustainable land use strategies for these areas by 2050 and to assess their impacts on biodiversity, climate, quality of life and environmental risks. At the same time, they should incorporate the wishes, goals and needs of the different participants while taking into account political trends and European Union policies.

An important point of discussion were issues related to project management - e.g. potential risks, but also the preferences for the form of cooperation were addressed. It was also discussed whether the project leaders expect clear work assignments and more control from the leaders of the work packages, or whether freedom in finding ways to solve the tasks and creativity are important for them.

During the meeting, all partners had the opportunity to express their expectations from the project, especially when it comes to academic outputs (publications and conferences) or practical functioning (tools for setting up better planning and management of the regions and areas involved). The participants of the meeting were invited to a gala Glass of Wine in the Clam-Gallas Palace in the center of Prague, to which also the representatives of Czech scientific institutions and state administration dealing with issues of sustainability, climate change and the environment, as well as representatives of the embassies of the countries represented in the project, were invited. The event was thus another opportunity for informal discussion both for the participants of the meeting and for the invited guests.

HALF A MILLION YEARS OF CLIMATIC EVOLUTION OF FOREST BIOMES IN THE MEDITERRANEAN

GOT OUR ATTENTION

Continued warming raises concerns about how long forest ecosystems in particular can absorb increasing volumes of carbon dioxide emissions. On a global scale, the rate of carbon sink of forest ecosystems is still increasing, but regionally it is already being disrupted. The upcoming summer is marked by record drought in Spain and a potentially above-average forest fire season. A new analysis evaluating the climate development of ecosystems in the Mediterranean over the past 500,000 years provides an insight into the possible fate of forests in this area. The results of an international team of scientists were published in the journal *Nature Communications*.

The longer and more detailed data on the evolution of climate forcing can be obtained, the better and more reliable the forecasts will be in connection with the ongoing or expected consequences of anthropogenic climate change. To analyze the effect of climate on forest biomes over the past half a million years, scientists have used fossil pollen grains preserved in sediments in the region of north-eastern Greece. Forests in the Mediterranean are characterized by rich biodiversity and the provision of critical ecosystem services, such as protection against soil erosion, regulation of regional climatic and hydrological conditions, provision of wood and food, and last but not least, carbon sequestration.

In the study, researchers led by Andreas Koutsodendris combined data on pollen grains and geochemical data revealing the amount of rainfall in the past. One of the key conclusions is that in the case of exceeding the critical threshold of the minimum amount of precipitation, there will not be a gradual but a rapid transformation of forest ecosystems (lasting on the order of several decades) into steppe ecosystems. This critical threshold is represented by a decrease in precipitation by 40-45% compared to the state of precipitation in the interglacial (Fig. 1). Ecological models have helped identify the natural causes of past rainfall fluctuations. The authors point out that a further increase in the average temperature of 2 °C compared to the present will result in a 30% decrease in precipitation. This expected decrease, combined with the already existing decrease, the subsequent increase in soil drought and other anthropogenic factors may cause an irreversible and rapid transformation of forests into steppe ecosystems. Therefore, it is necessary to take such measures in the Mediterranean that will locally increase the resilience of forest ecosystems to the above mentioned negative factors. -aa-

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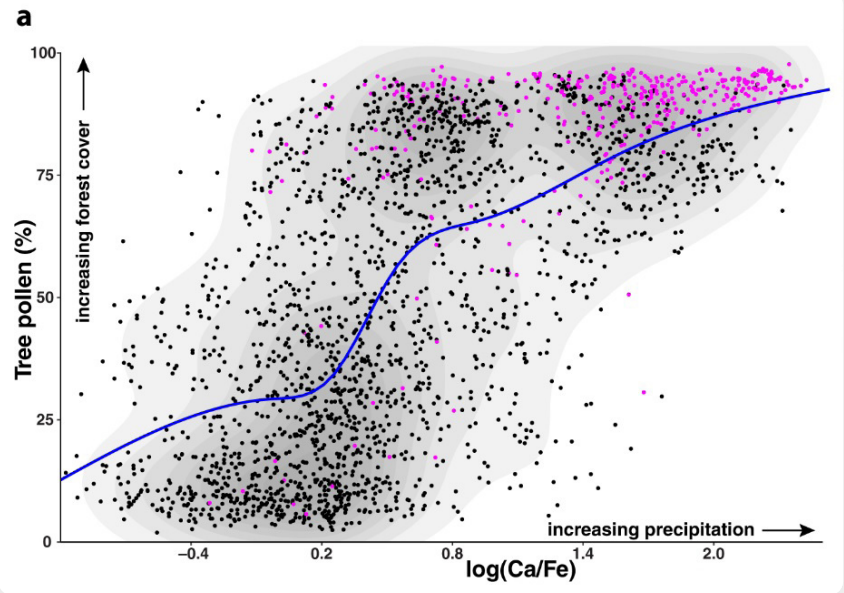

Fig. 1: *Plot of the percentages of pollen grains and logarithm of Ca/Fe ratio values in sediments. A higher proportion of pollen grains means a higher proportion of trees/forests in the ecosystem, and a higher proportion of Ca/Fe means more precipitation. Instead of a linear relationship, a rapid transformation of the forest into a steppe can be observed when precipitation decreases by 40-45% compared to the maximum values of precipitation. These are represented by purple dots when the CO_2 concentration value exceeded 260 ppm (interglacials). The gray shaded areas represent the concentration (amount) of data. The blue line represents the Generalized Additive Model (GAM).*

WHAT´S NEW

Christian Körner received the Gregor Johann Mendel Medal

On 6th January 2023 in Brno, Christian Körner, bioclimatologist and IPCC member received the Gregor Johann Mendel Honorary Medal for Merit in the biological sciences awarded by the Czech Academy of Sciences. The nomination to award the medal to Professor Körner of the University of Basel was submitted by the GCRI, with whom Professor Körner had collaborated on ecosystem experiments based on controlled climate conditions. At the same time, Christian Körner, as a long-standing member of the international SAEB of CzechGlobe, had been involved in the formulation of the research strategy on the impacts of climate change on ecosystems and in the development of innovative methodological approaches.

Opening of the Ecosystem Station in Ghana

On 8th March 2023, the ecosystem station in the Bia Tano Forest Reserve in Ghana was ceremonially put into operation. The station for monitoring the carbon fluxes in the tropical rainforest is a pilot project of the GCRI and the University of Energy and Natural Resources in Sunyani, Ghana, aimed at monitoring climate change and promoting adaptation to it at the regional and national level. The project will provide unique data and its practical application, as well as education in the field of ecology. The equipment of the tower with measuring systems and sensors was provided by CzechGlobe scientists and technicians together with Ghanaian colleagues who had completed their doctoral studies in Brno.

Science fair

From 8th till 10th June 2023, the next year of the Science Fair organized by the Czech Academy of Sciences took place at the exhibition center in Prague - Letňany. This time, CzechGlobe presented itself with the exhibition entitled The Story of Trees, which was prepared by the Department of Xylogenesis and Biomass Allocation. Visitors could see how trees grow in response to drought, how roots grow, what happens to the tree trunk during the day, what information can be learned from wood structure, how wood structure differs in different types of trees and how it all relates to their ability to adapt to environmental conditions.

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