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Contents

About ENVIMET project

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Project coordinator	Global Change Research Centre AS CR, v. v. i.
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Project Description

The main objective of the project is to create a top-notch scientific team with the participation of foreign experts and which will join new methods of environmental metabolomics and plant ecophysiology to contribute in resolving issues of how plants adapt and acclimate to expected global environmental changes, short-term abiotic and biotic stresses, and extreme meteorological events.

Sub-objectives of the project:

a) To assemble a multidisciplinary team of experts in plant ecophysiology and environmental metabolomics which will be able comprehensively investigate problems of global change impacts from the molecular to ecosystem levels.

b) To integrate the team into international excellence networks dealing with ecophysiology and environmental metabolomics (AnaEE, INTERFACE, CLIMMANI, UV4Growth, EPPN, and others).

c) To promote direct bilateral cooperation with leading foreign research institutions and universities (CNR Roma, Italy; University of Vienna, Austria; Centre for Ecological Research and Forestry, Spain; University of Helsinki, Finland; Forschungszentrum Jülich, Germany, and others).
d) To support the involvement of young scientists and PhD students in international cooperation, enable their access to cutting-edge methodological approaches and knowledge. This goal is achieved by support to international fellowships and organizing training schools.
e) To organize an international conference with the participation of leading international experts and thereby create a platform for knowledge transfer with the aim to further interconnect plant ecophysiology, environmental metabolomics, and other scientific disciplines.

Innovation:

The establishment of a multidisciplinary scientific team enables comprehensive investigations into the impacts of global change from the molecular to ecosystem levels. Key methodical approaches include manipulation experiments examining the interaction of multiple stressors on plants, ecophysiological studies, metabolic profiling and fingerprinting using GC-MS/MS, LC/HRMS, FT-IR, Raman microscopy, spectrofluorometry, and other methods.

To date, biochemical analyses in plant ecophysiology have focused mainly on target groups of specific metabolites, such as sugars and/or phenolic compounds. A fundamental advantage of metabolomics lies in the fact that a comprehensive spectrum of metabolites can be evaluated in connection with certain traits or stress response, thus allowing the detection of heretofore unknown mechanisms of adaptation.

The project established functional linkages between manipulative experiments, physiological analyses, metabolic profiling, and plants production. Experiments focus on evaluating interactions among multiple environmental factors, such as the influences of drought, elevated CO2 concentrations, increased UV radiation, temperature, mineral nutrition, changes in radiation's spectral composition, among others. These interactions aim to simulate expected long-term changes in the growth environment in connection with global change, but also short-term effects of fluctuations and weather extremes.

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ABSTRACTS OF ORAL PRESENTATIONS

Human Impacts on the Climate System

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Human impact on the planet over the last century has been substantial. The natural cycles of carbon and nitrogen, and the flows of energy and water have been altered, impacting the climate system. Meanwhile, the human population has expanded vastly and is now 7 billion. So there are more mouths to feed than ever before, putting pressure on land and soils, and prompting questions about the Earth's ultimate carry capacity. Forests, and the rich biodiversity they contain, are shrinking fast as agriculture necessarily expands. But as climate warming proceeds, land will become droughted and many of the food-producing regions of the world will have to be abandoned. Moreover, it is clear that the resources and opportunities that the world provides are not equally distributed and human societies are becoming increasingly divided in terms of health and wealth, a process which leads inevitably to political tension and conflict. However, scientific discoveries are rapidly improving our understanding of the life support system of the planet, and the scientific community is better-organised, more trans-disciplinary, and more effectively connected to government. Recent advances provide humanity with new powers to think about, predict and manage the future challenges.

Acknowledgement

Support has been from UK's Natural Environment Research Council through the Amazonica project (ref NE/F005040/1), and from the European FP7 project Geocarbon (ref FP7-ENV-2011, 283080).

How CMIP5 bias can invert the precipitation response in Eurocodex: the Aladin

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The Cordex experimental set-up prescribes that regional models are directly driven by CMIP5 simulation, without double nesting or spectral nudging technique. We have used Aladin-climate model (Colin et al., 2013) driven by CNRM-CM5 (Voldoire et al., 2014) on the Eurocordex domain. The Summer precipitation response in RCP8.5 at the end of the 21st century is an increase over France, in contradiction with most of the FP7-ENSEMBLES models, including Aladin. In fact, Summer precipitation is too high in the historical runs. If we rerun the global simulations with corrected sea surface temperature, and drive the regional model again, the precipitation bias is reduced in the historical run, and the precipitation response is a decrease. Just correcting sea surface temperature in the regional model is not sufficient. Additional simulations with a higher resolution GCM (uncoupled, but using corrected/uncorrected CMIP5 sea surface temperatures) confirm this behaviour. It is therefore important to either use a driving GCM with a small bias near the lateral boundaries, or to apply a double nesting strategy

References

Colin J, Déqué M, Radu R and Somot S (2010) Tellus A, 62, 591–604.
Voldoire A et al. (2013) Climate Dynamics, 40, 2091–2121.

Acknowledgement

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Heat waves over Central Europe in the Aladin-Climate/ CZ regional climate model

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Heat waves have substantial impacts on human society and the natural environment, causing excess illness and mortality, increased energy demand for cooling, forest fires, spreading of pests, crop failure, and other economic losses (Beniston et al. 2007). Due to a projected rise in the global mean air temperature and possibly also an enhanced length and frequency of atmospheric blocking events over the Euro-Atlantic region due to the Arctic Amplification (Francis and Vavrus 2012), heat waves are expected to become more severe under the ongoing climate change.

The aim of this study is to analyse characteristics of Central European heat waves in the regional climate model Aladin-Climate/CZ (Farda et al. 2010), driven by the ARPEGE global climate model. Observed dataData observed for model evaluation areis taken from the E-OBS dataset (Haylock et al. 2008). A heat wave is defined based on the daily maximum temperature in summer, with spatial and temporal criteria imposed (Lhotka and Kyselý 2014).

The first part of the study is focused on the evaluation of simulated Central European heat waves in the historical time period of 1961-2000 period. We investigate the model capability to reproduce temperature amplitude, length, spatial extent, overall magnitude, and the number of heat waves. In the second part, the simulation of heat waves in the future climate is analysed. The simulation is forced by the SRES A1B emission scenario and covers the time period of 2001-2050 period. We study changes in heat wave characteristics, with respect to the findings from the first part of the study.

The results will bring additional information of heat wave characteristics in the future climate, since Aladin-Climate/CZ has not been employed within international projects, such as ENSEMBLES and EURO-CORDEX. Increasing the number of available simulations provides more robust estimates of future climatic conditions, which are essential for impact studies as well as the design of suitable adaptation and mitigation strategies.

References

Beniston M et al. (2007) Clim. Change 81, 71–95.
Farda A et al. (2010) Stud. Geophys. Geod. 54, 313–332.
Francis JA, Vavrus SJ (2012) Geophys. Res. Lett. 39, L06801.
Haylock MR et al. (2008) J. Geophys. Res. 113, D20119.
Lhotka O, Kyselý J (2014) Int. J. Climatol., DOI: 10.1002/joc.4050.

Attribution of European temperature variability in the 1882-2010 period: A statistical perspective

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The problem of attribution, i.e. identification of the causes of observed climate variability and quantification of their effects, is among the prime focal points of contemporary climatology. Along with GCM-based climate simulations, statistical methods are typically used for that task. In this presentation, we employ linear techniques of regression analysis to detect imprints of prominent external climate forcings, anthropogenic (representing the amounts of human-released greenhouse gases and aerosols) or natural (variations of solar and volcanic activity), as well as major modes of internal climate variability (El Niño/Southern Oscillation – ENSO, North Atlantic Oscillation – NAO, Atlantic Multidecadal Oscillation – AMO, Pacific Decadal Oscillation – PDO) in the gridded monthly temperature data characterizing the European region. Temperatures obtained from the GISTEMP and Berkeley Earth datasets were investigated for the 1882-2010 period. We show that the presence of components correlated with greenhouse gases concentrations is generally strong in European temperatures, and typically combined with a mild cooling effect ascribed to anthropogenic aerosols. Components attributable to variations of solar activity are mostly weak and statistically insignificant, as are imprints of large volcanic eruptions. Our analysis confirms a strong association between the phase of NAO and the temperature in most of Europe. On the other hand, temperature oscillations synchronized with ENSO are quite limited in magnitude, and their level of statistical significance is low. The influence of the North Atlantic SST, embodied by the AMO index, is noticeable particularly in the westernmost parts of the European region, whereas a significant PDO influence seems to extend to Scandinavia. The observation-based GISTEMP and Berkeley Earth datasets were also compared to the 20th Century Reanalysis; we show that while many of the features of the (pseudo)observed data are reproduced well by reanalysis, some distinctions appear.

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Empirical and modelling approaches for heat risk assessment in urban climate under climate change (Case study for Brno, Czech Republic)

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Typical features of air temperature variability and the development of urban heat islands (UHI) are among the most characteristic expressions of urban climate. They have a direct impact on the quality of life and the health environment of the urban population. UHI may contribute to imminent problems of higher heat risk for city dwellers, particularly in view of recent climate changes.
Our study introduces two approaches that were used for the analysis of air temperature variability in Brno and surroundings. The first approach was based on data gathered from standard meteorological measurements taken within the CHMI network, as well as from special-purpose measurements from a network of 16 stations. Several explanatory variables that explained a substantial part (more than 50%) of air temperature variability were used to set up a regression model. This model allows the identification of the most important local factors influencing air temperature and the mapping of areas with the highest air temperatures in city of Brno. For these areas the above-average density of buildings and lower density of vegetation are typical. The mean UHI intensity in the early night in summer reaches its highest (approximately 5°C) values near the city center and decreases towards the suburban areas.
The second approach utilizes the three-dimensional microscale urban climate model MUKLIMO_3 provided by Deutscher Wetterdienst, Offenbach, Germany. We describe typical features of the model and validate the first modelling results. We demonstrate that the model provides realistic estimates of several air temperature characteristics (e.g. daily minimum and maximum temperatures, number of summer days) for the Brno region. The successful validation of the model will allow us to construct various scenarios of the Brno urban climate under future climate changes.

Acknowledgements

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Dynamics of the emissions of biogenic volatile organic compounds above the peri-urban Holm oak forest of the Mediterranean coast

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Bi-directional exchanges of Volatile Organic Compounds (VOCs) were investigated on a Mediterranean peri-urban Holm oak forest in Castelporziano presidential estate near the coast of the Tyrrhenian Sea, 20 km from the downtown of Rome, Italy. Two field campaigns were carried out in January and August 2014 to explore VOC fluxes in two seasons with different climate conditions. The concentration of 23 compounds was measured using a proton transfer reaction - mass spectrometer (PTR-MS, Ionicon Analytik GmbH). These included biogenic products (BVOC – isoprene, monoterpenes), oxygenated BVOC (OVOC) and VOC of anthropogenic origin (AVOC). In 30-minute intervals we switched between a measurement at high frequency eddy covariance above the canopy and sample for half an hour at 5 gradient levels from soil to above the canopy. Eddy covariance was used to calculate fluxes, while gradient measurements were used to estimate in-canopy source and sink distribution by applying the Inverse Lagrangian Transport Model (Raupach et al., 1986; Karl et al., 2004). Secondary pollutants as ozone and NOx were also measured for better understanding of their reactions with BVOCs and among each other (Fares et al., 2014). During winter fluxes were negligible, whereas in summer monoterpenes were up to 8 nmol m–2 s–1 during midday in response to high radiation and temperature. OVOC source-sink distribution analysis was performed to help identifying the canopy layers which mostly contributed to VOC exchanges, thus underlining the importance of forest canopies in VOC exchanges in the soil-plant-atmosphere continuum. AVOC concentration in winter was double compared to summer, despite the intense vehicular traffic in August to the beach nearby the forest stand. Both in winter and summer, emissions of AVOC from the forest were measured, although we excluded a biogenic source but rather a resuspension of compounds previously accumulated at night under a shallow atmospheric boundary layer. Here we discuss the importance of forest canopies in the interaction between VOC and secondary pollutants, such as ozone and NOx in a peculiar Mediterranean site where the sea-land breeze circulation allows a strong mixing of contaminated air from the city and cleaner air from the sea under high UV radiation and temperature.

References

Raupach MR (1989) Agr. Forest Meteorol. 47, 85–108.

Karl T et al. (2004) J. Geophys. Research, 109.

Fares S et al. (2014) Agr. Forest Meteorol 198-199: 181–191.

Acknowledgement

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Analysing imperfect large environmental data with case studies on climate change

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Since the Global Change Research Centre produces large data sets and our goal is mainly to manage them, to mine information, and to interpret them we need a statistical approach. We have listed some of the main problems present in almost every environmental data set. The reasons why attention should be paid to them and how to solve such problems are briefly presented.

Outlier values may have various causes, such as method limitations, instrument failures, yet they are also a natural component of environmental data sets. In general, detection methods for outlier values are very case (site) specific due to the problem specificity investigated, complex measurement techniques and characteristics of the site. The problem of data gaps has similar reasons as in the previous case. Data are usually incomplete without any possibility to complete them by measurements. Incompleteness is usually a problem when gaps are not randomly distributed or in the case of computing seasonal statistics. So called gapfilling methods exist for the purpose of replacing gaps by values. Multicolinearity (correlation of variables) is a problem limiting the application of standard statistical methods, such as regression. From correlated variables only independent ones can be chosen for further calculations, ideally those with the highest importance. Not-normal data distribution is also a limitation of standard statistical methods, which usually assume normal distribution. In case of large data sets asymptotic normality can be assumed in many cases. However, there are examples of variables (such as precipitation) for which this assumption does not apply. There are two possible ways how to solve this: to transform the data or use non-parametric methods.

We present two examples of data analysis. The first solves the problem of radiation use efficiency at a Norway spruce forest stand at Bílý Kříž, Beskydy mountains. The data set contains a 10-year time period (2003-2012) of eddy covariance measurements and meteorological parameters. The second example deals with the validation of one-minute measurements of concentrations of tropospheric ozone measured at three different height levels (50 m, 125 m, 230 m) at AS Křešín u Pacova. The aim of the proposed method is to identify invalid measurements and mark high differences of one-minute ozone concentrations.

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The seasonal cycle of boreal forests: a remote sensing perspective

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Northern ecosystems are especially likely to be affected by climate change. Therefore, understanding the seasonal dynamics of boreal ecosystems and linking their phenological phases to satellite reflectance data is crucial for efficient monitoring and modelling of northern hemisphere vegetation dynamics. Satellite remote sensing enables continuous global monitoring of the vegetation status (and potentially also physiological processes of vegetation), and thus, it is not limited to conventional, single-date phenological metrics, such as budburst or flowering. Using remote sensing also enables gaining a wider perspective to the seasonality of vegetation dynamics. At its best remote sensing can reveal large-scale phenological trends that would be impossible to detect from the ground.

The seasonal reflectance course of a boreal forest observed in remote sensing data is a result of the temporal cycle in optical properties of both the tree canopy and understory layers. Seasonal reflectance changes of the two layers are explained by a complex combination of changes in biochemical properties and the geometrical structure of different plant species as well as seasonal and diurnal variations in solar illumination. Analysing the role of each of the contributing factors can only be achieved by linking vegetation reflectance modelling to empirical reflectance data sets.

The poster provides an overview of our research project (2010-2015) which has focused on quantifying the seasonal reflectance changes and their driving factors in European boreal forests.

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Remote sensing activities at CzechGlobe: a caste study of chlorophyll content retrieval from airborne hyperspectral data of a beech forest

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Airborne hyperspectral remote sensing (RS) offers a link between local ecosystem studies and regional to global studies, which are typically based on satellite remote sensing. Therefore, the main research activities of the Department of Remote Sensing at CzechGlobe comprise the development of retrieval methods for the estimation of vegetation properties from airborne hyperspectral data and potentially from satellite RS data, such as those of the ESA's upcoming Sentinel-2 satellite mission.

The objective of this contribution is twofold. First, we introduce a new remote sensing facility at CzechGlobe that is being used to acquire high quality airborne RS data. The core of this facility is an airborne carrier equipped with a suite of hyperspectral sensors covering the visible, near infra-red and thermal spectral domain, and an airborne laser scanner. In this contribution we would like to outline potentials of different types of RS data for different ecosystem analyses and how this can be further linked and expanded to satellite-based RS.

Second, we present in more detail a study demonstrating how RS data can be used for quantitative estimation of biochemical properties in a broadleaf forest. The ecosystem research station Štítná nad Vláří dominated by European beech forests was selected as a test site for this case study. High resolution airborne hyperspectral images were acquired on this site in the summer of 2013. We employed the advanced canopy radiative transfer model DART coupled with the leaf-level model PROSPECT for the interpretation of the RS images. Radiative transfer models provide an explicit link between vegetation biochemical and structural properties and canopy reflectance (Jacquemoud et al. 2009). Therefore, these models were used to build up a spectral database of simulated canopy reflectances. This database was subsequently used to train a machine learning algorithm, namely support vector machines, to estimate the chlorophyll content from RS images.

Preliminary results using the spectral database confirmed that support vector machines are well suited as a robust tool for the estimation of forest chlorophyll content. Although the chlorophyll retrieval accuracy decreased when applied on real hyperspectral images due to their inherent noise and calibration artefacts, the accuracy expressed as root mean square error calculated between field measured and retrieved chlorophyll content was good (i.e. typically below 10 μg cm-2).

The advantage of this retrieval method is that it can be adapted to other types of RS data, such as the upcoming Sentintel-2 satellite data. Moreover, the results from airborne hyperspectral images can be used to verify retrievals from satellite RS data.

References

Jacquemoud S et al. (2009) Remote Sensing of Environment 113, S56–S66.

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Hyperspectral remote sensing of beech (Fagus sylvatica) leaves across the chlorophyll gradient and during the seasonal course: from leaf to canopy level

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Remote sensing methods allow to evaluate critical aspects of carbon balance in terrestrial ecosystems at the global scale and over short time scales. Recent advances, thanks to hyperspectral sampling, enable a direct observation of dynamic photosynthetic processes, closely related to light use efficiency and photosynthesis. In the study presented we combined hyperspectral non-imaging leaf level measurements and imaging canopy level measurements with active chlorophyll fluorescence measurements, gas-exchange measurements and chlorophyll content estimation of beech samplings (Fagus sylvatica). We used four treatments with a combination of different amounts of nitrogen supply and partial shading covers with 25 % transmittance of the incoming solar radiation in order to obtain contrasting chlorophyll contents of leaves. We measured the hyperspectral reflectance, carbon assimilation, steady-state chlorophyll fluorescence and chlorophyll content (in relative SPAD units) of leaves in a seasonal course during four field campaigns between the 11th of June and 23rd of September. Our results show that there is a close, statistically significant relationship between the CO2 assimilation rate under saturating light intensity (Amax) and chlorophyll content, between Amax and the steady-state intensity of chlorophyll fluorescence (FS). Furthermore, we found that there is a significant relationship between the chlorophyll index (R750-R705)/(R750+R705) (where R is the reflectance at subscripted wavelength) and Amax at both, leaf and canopy scales. Also, the FS indicator could be tracked using selected hyperspectral vegetation indexes. In this work we show that optical remote sensing methods can be used to accurately track carbon assimilation, as well as the intensity of the chlorophyll fluorescence signal over the course of the vegetation season at both, leaf and canopy scales, thus potentially enabling the upscaling to the satellite level of remote sensing.

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Convergence of morphological, biochemical and physiological traits of upper and lower canopy European beech leaves and Norway spruce needles within altitudinal gradients

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Climatic variation along altitudinal gradients provides an excellent natural experimental set-up for investigating the possible impacts of climate change on terrestrial organisms and ecosystems. There are five primary changes in microclimates associated with high altitude: decrease in partial pressure of gases, reduced temperature and clear-sky turbidity, a higher fraction of ultraviolet radiation and higher precipitation. The present work has explored for the first time acclimation of upper versus lower canopy leaves/needles of European beech (Fagus sylvatica) and Norway spruce (Picea abies) forests along an altitudinal gradient. We tested the hypothesis that restrictive climatic conditions associated with high altitudes reduce within-canopy variations of leaf traits. The investigated beech and spruce forest is located on the southern slope of the Hrubý Jeseník Mountains (Czech Republic). All measurements were taken on leaves from upper and lower parts of the canopy of mature trees (>60 years old) growing at low (400 m above sea level, a.s.l.), medium (720 m a.s.l.) and high (1100 m a.s.l.) altitudes.

Although the physiological and biochemical traits in the upper canopy varied according to the changes in microclimatic conditions within the altitudinal gradient, the leaves/needles from the lower canopy generally tend to converge with the upper canopy when the altitude increased. A similar convergence was observed in the nitrogen content, C:N ratio or light saturated CO2 assimilation rate (Amax) for both species studied. On the other hand, a strong convergence of flavonol content and total chlorophylls observed in beech was not found in Norway spruce. The relationships between stoichiometric (N,C), biochemical (Rubisco content), morphological (LMA) and physiological parameters (Amax) and their changes with altitude will be discussed. Although the structural parameters (density, height and age) of the canopies studied allow assuming a similar light environment at all altitudes. The hypothesis of convergence of upper and lower canopies with higher altitudes was proved in most morphological, physiological and biochemical traits.

Our results show that a limiting role of the light environment in favourable climatic conditions of low altitudes is reduced at high altitudes where a limiting role of climate constrains for growth (e.g. temperature) is crucial. Thus, the great capacity of trees being able to adjust to the whole canopy in order to cope with changing conditions has been demonstrated.

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Automated eddy covariance data quality control for long-term measurements

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The Eddy covariance (EC) method allows for long-term observations of heat, water and carbon dioxide (CO_2) exchange between the atmosphere and biosphere under conditions of a changing climate. EC towers are often organised into networks either on a continental scale (e.g. ICOS, NEON) or a national scale (e.g. CzeCOS, TERENO). This presents a challenge for the unification of the data processing methodology, i.e. raw data post-processing, quality checking (QC) and gap-filling of missing data (Foken et al., 2012). So far there is no universally accepted set of tests for EC flux quality flagging, but an effective QC scheme was already presented (Mauder et al., 2013). In this study we therefore aim to assess the reliability of the adopted approach to flag half-hourly CO_2 flux data with a lower quality. For the analysis we selected two site-years from contrasting ecosystems, a mature European beech forest (Štítná nad Vláří-Popov, Czech Republic) and mountainous grassland (Bílý Kříž, Czech Republic). In the original study, Mauder et al. (2013) applied the tests by using the post-processing software TK3.1 (Mauder and Foken, 2011). Although we used EddyPro software (LICOR, USA), most of the corresponding tests were available (plausibility limits, number of missing values, stationarity tests, tests of integral turbulence characteristics, tests of mean residual vertical wind component and flags interdependency due to corrections). Automatically generated quality flags will be compared with the previous approach relying on visual inspection and a different set of tests. The automatic QC can be accepted only if it succeeds in labelling low quality data and preserves an appropriate amount of flux values. If the method proves successful, it will improve the reproducibility of data processing and save a considerable amount of time needed for quality assurance.

References

Foken T, et al. (2012). In Aubinet M, et al. (eds.), Eddy Covariance: A Practical Guide to Measurement and Data Analysis. Springer, Dordrecht, pp. 85-132.

Mauder M, Foken T (2011) Documentation and Instruction Manual of the Eddy-Covariance Software Package TK3. Univ. Bayreuth, Abteil. Mikrometeorol.: Arb. 46, 60 pp.

Mauder M, et al. (2013) Agric. Forest Meteorol. 169, 112-135.

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The effect of water level and temperature on methane emission from a sedge-grass marsh

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Methane is an important contributor to the greenhouse effect after water vapour and carbon dioxide. The air concentration of methane is usually around 1.9 ppm (Schlesinger, 2012). Methane is naturally produced by wetland ecosystems as a product of anaerobic decomposition processes of organic matter in water-saturated soils (Le Mer and Roger, 2001). Sedge-grass marshes are wetland ecosystems usually with a fluctuating water level and other changing environmental parameters, such as air and soil temperatures, solar radiation and others. The processing of methane production and its emission is closely related to actual environmental conditions. However, these relations are not simply directly linked to methane emissions. Methane emissions responded to the changing conditions with some time delay. We tried to analyse and quantify this delay using the (sample) cross-correlations analyses. A high water level increased methane emissions. The response of methane emissions to the changes of the water level can be immediate (0 days of delay, mainly in the spring) or a delay of about 2 to 8 days (mainly in the summer). Delays were different for different areas measured. The effect of the temperature seems to be more complicated in most of the cases due to the effect of the third variable (for instance some aspects of global climate). Detailed knowledge of possible delays of methane emission is important for possible methane emission prediction and understanding the behaviour of the whole wetland ecosystem.

References

Le Mer J, Roger P (2001) Eur. J. Soil Biol. 37, 25–50.

Schlesinger WH (2012) Biogeochemistry: an analysis of global change. 3rd edition. New York: Elsevier/Academic Press.

Fluxes of nitrous oxide and methane from boreal upland forest

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The boreal forests represent 73% of the world's coniferous forests, and they have been considered a significant natural sink of methane (CH_4) and a natural source of nitrous oxide (N_2O), important greenhouse gases naturally metabolized in soils. Even though both gases can also be emitted also from aboveground plant surfaces, the role of coniferous trees in ecosystem N_2O and CH_4 exchange is currently only poorly understood.

Our main objective was to i) determine whether and to which extent mature Scots pine trees (Pinus sylvestris L.), typical conifers of boreal forests, emit N_2O and CH_4 from stems and shoots under natural conditions, and ii) to upscale these fluxes from individual trees to stand level. N_2O and CH_4 fluxes from the bottom parts of stems, upper canopy shoots, and from the forest floor were simultaneously measured using static chamber systems and quantified by gas chromatographic analyses.

Our study shows for the first time that mature P. sylvestris trees can emit both N_2O and CH_4 from their aboveground surfaces under field conditions. Notably, the shoot emissions of N_2O and CH_4 considerably exceeded the stem emission rates, thus underlining the important role of forest canopies in the trace gas exchange of forests. Moreover, contrary to N_2O fluxes, the CH_4 fluxes from pine stems and forest floors suggest a positive correlation with soil moisture. The forest floor was either a sink or a source of CH_4, depending on soil water content. Even under rather dry conditions, typical offor the studied forest studied in Southern Finland, P. sylvestris emitted small amounts of CH_4 from its aboveground surfaces, whereas the forest floor was a sink of CH_4. Finally, the up-scaling of fluxes from individual trees to a hectare of a typical middle-age boreal pine forest showed that the CH_4 and N_2O emissions from trees constituted a significant part of the total flux of CH_4 and N_2O. Based on our findings, the N_2O emissions from boreal pine forests may be underestimated by 8% and the uptake of CH_4 may be overestimated by 1% as compared to the fluxes based on forest floor measurements only. This study therefore highlights the necessity to include N_2O and CH_4 emissions from trees into the total forest ecosystem greenhouse gases budget.

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Molecular adaptation of plants in a fluctuating environment – application of OMICS in the field

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Plants have shaped our human life form from the outset. With the emerging recognition of world population feeding, global climate change and limited energy resources with fossil fuels, the relevance of plant biology and biotechnology is becoming dramatically important. One key issue is to improve plant productivity and abiotic/biotic stress resistance in agriculture due to restricted land area and increasing environmental pressures. Another aspect is the development of CO_2-neutral plant resources for fiber/biomass and biofuels: a transition from first generation plants like sugar cane, maize and other important nutritional crops to second and third generation energy crops such as Miscanthus and trees for lignocellulose and algae for biomass and feed, hydrogen and lipid production. At the same time we have to conserve and protect natural diversity and species richness as a foundation of our life on earth. Here, biodiversity banks are discussed as a foundation of current and future plant breeding research. Consequently, it can be anticipated that plant biology and ecology will have more indispensable future roles in all socio-economic aspects of our life than ever before. We therefore need an in-depth understanding of the physiology of single plant species for practical applications as well as the translation of this knowledge into complex natural as well as anthropogenic ecosystems. Latest developments in biological and bioanalytical research will lead into a paradigm shift towards trying to understand organisms at a systems level and in their ecosystemic context: (i) shotgun and next-generation genome sequencing, gene reconstruction and annotation, (ii) genome-scale molecular analysis using OMICS technologies and (iii) computer-assisted analysis, modeling and interpretation of biological data. Systems biology combines these molecular data, genetic evolution, environmental cues and species interaction with the understanding, modeling and prediction of active biochemical networks up to whole species populations. This process relies on the development of new technologies for the analysis of molecular data, especially genomics, metabolomics and proteomics data. The ambitious aim of these non-targeted 'omic' technologies is to extend our understanding beyond the analysis of separated parts of the system, in contrast to traditional reductionistic hypothesis-driven approaches. The consequent integration of genotyping, pheno/morphotyping and the analysis of the molecular phenotype using metabolomics, proteomics and transcriptomics will reveal a novel understanding of plant metabolism and its interaction with the environment. The analysis of single model systems – plants, fungi, animals and bacteria – will finally emerge in the analysis of populations of plants and other organisms and their adaptation to the ecological niche. In parallel, this novel understanding of ecophysiology will translate into knowledge-based approaches in crop plant biotechnology and marker- or genome-assisted breeding approaches. In this lecture the foundations of green systems biology are described and applications in ecosystems research are presented. Knowledge exchange of ecosystems research and green biotechnology merging into green systems biology is anticipated based on the principles of natural variation, biodiversity and the genotype–phenotype environment relationship as the fundamental drivers of ecology and evolution.

References

Weckwerth W (2011) Green systems biology—from single genomes, proteomes and metabolomes to ecosystems research and biotechnology. Journal of Proteomics 75: 284–305.

Examples of application of metabolomic profiling in ecosystem research and impact studies

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Metabolomics is an 'omics' approach that aims to analyse all metabolites in a biological sample. Metabolomic profiling represents a new tool to ascertain the plants' response to biotic or abiotic stresses. The target and non-target metabolomic profiling is used for the analysis of various metabolomes and for studying plant-specific responses to biotic (pests) or abiotic stress factors (such as increase of UV radiation, drought, nutrient deficiency etc.). A combination of stress factors has a significant effect on the changes of metabolomes and can also be investigated in detail. Metabolomics can be applied for both laboratory and field experiments. Tandem analytical techniques and base analytical techniques are used for the analysis of metabolomes. Tandem analytical techniques are a combination of separation techniques (HPLC, GC high performance liquid and gas chromatograph) with MS (mass spectrometer) detection techniques. HPLC-HRMS (high performance liquid-high resolution mass spectrometer) is used for target and non-target analysis of polar and semi-polar primary and secondary metabolites (polyphenols, amino acid, sugars etc.). GC-MS is used for target analysis of non-polar metabolites or easily derivatisable polar metabolites (fatty acids, volatile compounds etc.). Basic analytical techniques, such as IR, Raman IR, fluorescence or classic spectrometers are used as complementary analytic techniques for the rest of the metabolites (content of chlorophyll, carotenoid, and xanthophyll pigments in leaf samples). The elemental analyser is used for the determination of nitrogen, carbon and sulphur content. The C/N/P stoichiometry plays an important role for metabolism as well as stoichiometry of other nutrients, such as calcium, magnesium, and potassium.

The results from the measurement are subsequently processed via statistic software for metabolomics (modified MatLab, R or Sieve). For the identification of metabolites we are using the Metlin database and our own mass library, which contains over 300 metabolites. KEGG is generally used for the metabolic pathway description and for finding what metabolic pathways (metabolites) are affected (synthesis sugars, amino acid, etc.) by stress. Information from non-target analysis is further used for target analysis. The overall results from metabolomic profiling are combined with results from physiologic measurements. The main aim is to find a relationship between the changes of metabolomes and changes in their physiological level caused by stress. The main experiments are focused on plants' responses to seasonal changes, altitude gradient, effects of enhanced UV radiation, drought, elevated CO2 concentration, other biotic/abiotic stress factors, as well as their combinations.

Within this presentation the examples of changes in the metabolome profile (i) in sun and shade acclimated leaves of European beech trees grown along the altitudinal gradient and (ii) in barley varieties exposed to enhanced ultraviolet radiation (UV) will be shown.

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Raman spectroscopy in biomolecular analysis

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Raman spectroscopy is a powerful tool for the identification of both inorganic and organic compounds. The advantage of the method relies on a nondestructive nature of the analysis without the necessity for sample pre-treatment, the possibility to analyze small sample volumes (e.g. ~1 m^3) and spectral mapping of the spatial distribution of analytes within undisturbed biological samples. In contrast to infrared spectroscopy, there is no interference with the water signal.

The aim of this contribution is to show possibilities of Raman spectroscopic analysis for the detection and identification of biomolecules within various types of biological systems. Several examples are shown with emphasis on pigments. This group of molecules originates mainly from a photosystem of higher plants, prokaryotes as well as algae. In addition to the light-harvesting function of pigments, some pigments act as photoprotective molecules, particularly under excessive light conditions (e.g., xanthophyll cycle pigments or screening molecules).

Due to their chemical and physical nature resulting in optical properties, pigments are important organic compounds in Raman spectroscopic analysis using visible excitation. The examples here range from phototrophic microorganisms to tissues of higher plants. Pigment composition was studied within two different ecosystems of phototrophic extremophiles (cyanobacteria and algae) living in crusts in one of the driest places on Earth, the Atacama Desert in Chile. Differences in carotenoid composition and variations in photosynthetic pigments, e.g. chlorophyll and phycobiliproteins have been observed. Moreover, calcium oxalate monohydrate has been detected, which is probably related to the metabolic activity of fungal hyphae surrounding the algae (Vítek et al. 2013). Importantly, spatial distribution of cyanobacterial and algal pigments including UV-screening compound scytonemin is shown using the rapid Raman imaging method (StreamlineTM) as well as subsequent data processing.

The role of the particular laser wavelength used for excitation is discussed and the 785 nm source is compared to the 514.5 nm laser wavelength on sunflower leaves as well as algae and cyanobacteria. In addition, the advantage of the 1064 nm excitation source in reduction of the fluorescence background is shown. The identification of Raman spectroscopic features of lignin and cellulose is demonstrated by the spectral record obtained from sections of spruce and beech wood tissue.

References

Vítek P, Cámara Gallego C, Edwrads HGM, Jehlička J, Ascaso C, Wierzchos J (2013) Geomicrobiol J. 30, 399-410.

Acknowledgement

This work has been supported by the Czech Science Foundation, project no. P210/12/P330. PV, KK thank to ENVIMET project CZ.1.07/2.3.00/20.0246, and CA and JW also thanks to the MINECO project CGL2013-42509P.

Seasonal changes in emissions and vertical distribution of volatile organic compounds within spruce canopy

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Biogenic volatile organic compounds (BVOCs) are produced by vegetation and have an impact on plant growth, reproduction and defence against biotic and abiotic stressors. They are emitted into the atmosphere and have a profound effect on atmospheric chemistry, particularly ozone production, and other organisms. The production of BVOCs is very variable, depending on the plant species and environmental conditions, especially light and temperature. Here, we present seasonal changes in emissions and vertical distribution of BVOCs within the spruce canopy profile.

BVOC emissions were measured on one-year old needles of Norway spruce (Picea abies (L.) Karsten) at the research site Bílý Kříž (Beskydy Mts.; 49°30´N, 18°28´E, CZ, 900 m a.s.l) in August and October 2013 and in July 2014. Samples were taken at two height levels, at 5 m above soil surface which represented shade acclimated needles and at 10 m which counted for sun acclimated needles. BVOC emissions were measured together with the CO2 assimilation rate (an open infrared gas Li-6400, Li-Cor, USA) and were sampled on Tenax tubes (Markes International, UK) under standard conditions (light intensity 1000 μmol m–2 s–1; temperature 30 °C). In addition, BVOC emissions were measured on-line using PTR–MS and PTR-TOF-MS (Ionicon, Innsbruck, Austria). Additional samples were taken to determine the content of terpenes, photosynthetic pigments and N, C ratio in spruce needles of both canopy heights.

The initial results show that the total BVOC emissions, measured at standard conditions were highest in the main growing season (July). Differences in BVOC emissions were, however, not so significant when the on-line measurements of BVOC emissions in July and October were compared. Terpene emissions from sun acclimated needles were approximately 30% higher than emissions from shade acclimated needles, although this was observed only in the summer. There was no difference between the upper and lower levels of the canopy at the end of the season. The most abundant terpenes were -, -pinene and eucalyptole in both types of needles. - pinene, camphene and terpinolene showed the most significant difference in emissions between sun and shade acclimated needles.

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Interactive effects of elevated CO2 concentration, drought and nitrogen nutrition on yield and grain quality of spring barley and winter wheat

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The interactive effects of elevated CO2 concentration (EC – 700 µmol mol-1), drought stress, UV exclusion and nitrogen nutrition were studied in open top chambers located in Domanínek near Bytřice nad Pernštejnem in the Bohemian-Moravian highlands (Czech Republic, 49°521'N, 16°235'E, altitude 575 m a. s. l.). This region is characterized as rainy area with a mean annual precipitation of 610 mm and a mean annual temperature of 7.2°C. The experiment consisted of 24 open-top chambers, which allowed the manipulation of CO2 concentration, precipitation and UV exclusion. The plots inside the chamber were divided into N-fertilized and unfertilized subplots.

Above-ground biomass at the time of the harvest, grain yield and grain quality parameters were studied in winter wheat (variety Bohemia) and spring barley (variety Bojos). The result showed that the elevation of CO2 concentration increased the above-ground biomass and grain yield. Higher level of nitrogen increased the stimulatory effect of EC on the above-ground biomass and grain yield. Also, UV exclusion stimulated the effect of the EC. EC generally led to increased rates of photosynthesis and the formation of assimilates. Increased storage of starch in the grain led to an unbalanced proportion of proteins and the decrease of their relative content in grain. Similar to grain yield and above-ground biomass also the decrease of protein content by EC was more pronounced under UV exclusion. EC led also to a reduction of other quality parameters, such as the Zeleny sedimentation test. This effect is more pronounced if nitrogen is not a limiting factor and under the effect of drought as well. A higher effect under drought stress is probably due to increased water efficiency.

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Towards chlorophyll fluorescence emission based plant phenotyping: Screening of cold tolerance in cold acclimated A. thaliana accessions

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An easy and non-invasive phenotyping platform is highly valuable to instigate research targeting the breeding of highly important cold and drought tolerant crops. Traditional methods are labour intensive, time-consuming and thereby of limited value for large scale screening (Hannah et al. 2006, Mishra A et al. 2011, Lukas et al. 2013). Here, we have tested the capacity of chlorophyll a fluorescence (ChlF) imaging based methods, employed advanced statistical classifiers and feature selection rules for finding combinations of images able to discriminate cold tolerant and cold sensitive plants. ChlF emission from intact whole plant rosettes of nine Arabidopsis thaliana accessions was measured for (1) non-acclimated (NAC, six-week old plants grown at room temperature), (2) cold acclimated (AC, NAC plants acclimated at 4 °C for two weeks), and (3) sub-zero temperature treated (STT, AC plants treated at -4 °C for 8 h) states. Cold acclimation broadened the slow phase of ChlF transients in cold sensitive (Co, C24, Can and Cvi) A. thaliana accessions. Similar broadening in the slow phase of ChlF transients was observed in cold tolerant (Col, Rsch, and Te) plants following ST treatments. ChlF parameters: maximum quantum yield of PSII photochemistry (FV/FM) and fluorescence decrease ratio (RFD) well categorized the cold sensitive and tolerant plants when measured in STT state. We trained a range of statistical classifiers with the sequence of captured ChlF images and selected the best classifier (QDC) in combination with sequential forward floating selection (SFFS) feature selection methods and found that a linear combination of three images showed a reasonable contrast between cold sensitive and tolerant A. thaliana accessions for AC as well as for STT states. We demonstrate that ChlF transients measured for intact whole plants are important for understanding the impact of cold acclimation on the photosynthetic processes. Combinatorial imaging methods worked well for screening of cold tolerance without exposing plants to sub-zero temperatures (Mishra A et al., 2014).

Furthermore, we are extending the scope of methods for phenotyping drought stress in natural accessions of A. thaliana. This might open up new possibilities for high-throughput monitoring of whole plants' cold as well as drought tolerance via easy and fully non-invasive means.

References

Hannah MA, Wiese D et al. (2006) Plant Physiol. 142, 98–112.
Mishra A et al. (2011) Plant Signal. Behav. 6, 301–310.
Lukas Vet al. (2013) Anal. Bio-Anal. Chem. 405, 2671–2683.
Mishra A et al. (2014) Plant Methods 10, 38–48.

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Detection of accelerated senescence of maturing rice panicles exposed to high-night temperature by chlorophyll fluorescence

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Flowering in rice is a critical developmental stage when seed numbers are determined, and along with the seed-filling phase are considered highly sensitive to environmental conditions. One major component accompanying the climate change is the rapid increase in minimum night temperature compared to maximum day temperature at a global, country and at farm level (Shah et al. 2011).

A feature of rice panicle ripening is the change in color as a consequence of chlorophyll disappearance, and since on the basis of chlorophyll, the photosynthetic capacity of a spikelet was found to be similar to that in a flag leaf (Imaizumi et al. 1990), a novel phenotyping approach using chlorophyll fluorescence was employed. Two contrasting rice cultivars, Gharib [high-night temperature (HNT) sensitive] and N22 [highly tolerant] (Zhang et al. 2013), were exposed to control (23°C) and HNT (29°C) from panicle initiation until maturity. Changes in the optical properties of rice panicles were evaluated by measuring (i) effective quantum yield of photosystem II efficiency (ΦII), (ii) steady-state chlorophyll fluorescence (FS) and (iii) ratio of emitted chlorophyll fluorescence at 690 and 735 nm, under excitation at 435 nm (F690/F735). To prove the accuracy of fluorescence measurements, selected Vis (Chen et al. 2006) were measured subsequently and correlated.

The effective quantum yield of photosystem II efficiency (ΦII) was selected as the most potent fluorescence parameter (a) to track changing optical properties of maturing rice panicles under both control and HNT and (b) to estimate the elusive change point initiating rice panicle senescence. Such a detection of ΦII change points allows for larger genetic diversity scans under field conditions and for identifying novel donors for increasing rice yields.

References

Chen Y, et al. (2006) Chi. J. Rice Sci. 20, 434–439.
Imaizumi N, et al. (1990) Jap. J. Crop Sci. 59, 321–326.
Shah F, et al. (2011) J. Agr. Sci. 149, 545–556.
Zhang Y, et al. (2013) Aus. J. Crop Sci. 7, 7–13.

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Elevated temperatures stimulate light induced processes that contribute to protection of photosystem 2 against oxidative stress

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The kinetics and extent of zeaxanthin (Z) formation, occurring after light (ΔpH) activation of the violaxanthin de-epoxidase (VDE) catalyzing deepoxidation of violaxanthin (V) to Z via an antheraxanthin (A) have been extensively studied as a crucial protective process mitigating oxidative damage of the thylakoid membranes. Particularly, Z dependent stimulation of ΔpH dependent non-radiative dissipation of excitation energy within photosystem II (NRD) is essential for photosystem II resistance against high light stress (Jahns and Holzwarth 2012). Recently, it has been shown that elevated temperatures can facilitate the activation of VDE and accelerate V deepoxidation upon illumination (Zhang et al., 2011).

In order to elucidate the variability of Z dependent photoprotection among different plant species, temperature dependence of V deepoxidation dynamics upon different illumination regimes, together with Chl a fluorescence changes (monitoring particularly the inductions of NRD), were studied in spruce seedlings (approx. 3 weeks after sowing) and Arabidopsis thaliana leaves (approx. 6 weeks after sowing). We tested the following hypotheses: 1, elevated temperatures accelerate both light induced V deepoxidation and NRD to a greater extent in Norway spruce than in A. thaliana; 2, instead of a limitation of deepoxidation reactions by V availability, the saturation of VDE due to a surplus of accessible V becomes a limiting factor in extremely rapid deepoxidation reactions in spruce seedlings exposed to elevated temperature.

Whereas in spruce seedlings the rapid phase of V deepoxidation (induced by either 10s illumination or 10 light-pulses of 1s duration at 1 min interval) was gradually stimulated upon increasing temperatures, in A. thaliana leaves a considerable acceleration of V deepoxidation occurred just at 40°C. Moreover, only in spruce seedlings a considerable amount of zeaxanthin (Z) was accumulated after 10x1s illumination. In agreement with these results, elevated temperatures stimulated a rapid formation of Z-dependent NRD induced by 1s light pulses only in spruce seedlings. The analysis of the initial phase of V deepoxidation during an illumination shorter than 10s indicated a saturation of VDE capacity in spruce needles at elevated temperatures. The conclusion of both postulated hypothesis have been confirmed. The possible role of specific fatty acid composition of spruce thylakoid membrane lipids in a facilitated V deepoxidation and NRD induction at elevated temperatures will be discussed.

References

Jahns P, Holzwarth AR (2012) Biochim Biophys Acta 1817, 182–193.
Zhang R et al. (2011) Photosynth Res 108, 171–181

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Supported by the National Sustainability Program I No. LO1415, Global Change Research Centre ASCR, v.v.i. (No. CZ.1.05/1.1.00/02.0073), GA CR No. 13-28093S/P501 and Ostrava University.

Characterization of autotrophic growth of a model cyanobacterium Synechocystis sp. PCC 6803 in a flat panel photobioreactor

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Cyanobacteria have gained increased attention as ideal candidates for biotechnological applications due to their capacity to produce valuable molecules ranging from therapeutic proteins to biofuels. Their natural phenotypic plasticity in highly dynamic environments allows easy deployment of new biotechnologies as well as open possibility for genetic engineering.

Here, we present a new approach to a fast and reliable characterization of cyanobacteria growth in a flat panel photobioreactor examined for changing light, temperature, inorganic carbon and the availability of other nutrients. The utilization of semi-continuous automatic cultivation with real-time culture growth monitoring provides a strong experimental base for both characterization and optimization of cyanobacteria cultures in photobioreactors. At first, we characterized the autotrophic growth of Synechocystis sp. PCC 6803 strain denoted as GT-L (Los et al., 2010; Los et al. 2013). This strain is capable of efficient growth under wide ranges of environmental conditions with a doubling time as fast as 5 hours under favorable conditions. However, differences between Synechocystis sp. PCC 6803 substrains have been identified on both genome and phenotype levels (Ikeuchi and Tabata, 2001; Kanesaki et al., 2012; Trautmann et al., 2012). Thus, we aim on utilization of our experimental platform for the characterization of other Synechocystis substrains. This will allow us to identify strains capable of robust growth coupled with high biomass production as reliable biotechnological candidates. Also, the identification of growth requirements for each particular strain is necessary for the correct interpretation of data obtained in widely used experimental sets.

References

Chen Y, et al. (2006) Chi. J. Rice Sci. 20, 434–439.
Imaizumi N, et al. (1990) Jap. J. Crop Sci. 59, 321–326.
Shah F, et al. (2011) J. Agr. Sci. 149, 545–556.
Zhang Y, et al. (2013) Aus. J. Crop Sci. 7, 7–13.

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Smart Governance: navigating behavior under the global change?

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SMART Governance represents a concept in navigating and managing individual and group behaviour for the mitigation and prevention of global environmental change under the complexity of the contemporary world. Purposeful behavioural change, considering institutional, technological and ecological fit, is seen as adaptation to enhance resilience of global socio-ecological systems. The key challenge of smart governance is to (i) foster the co-evolution of technological eco-innovations with institutional innovations; and (ii) to develop a mechanism for scaling down global issues and policy objectives such as climate change mitigation, land use abandonment and urban sustainability. Behavioural approaches model individual and collective actions under controlled conditions to reduce the uncertainty of information and the complexity of decision making. The presentation will concentrate on demonstrating smart governance using concepts of ecosystem services to foster the behaviour change of users to sustainability such as how climate regulation can address global climate policy objectives at local level and enhance resilience of European mountain regions or urban spaces.

Exploring climate change beliefs and attitudes towards adaptation among Czech citizens

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Climate change nowadays represents one of the major global environmental problems. In order to respond to these changes, adaptation actions at all levels, ranging from national to local level needs to be undertaken (EU Adaptation Strategy, 2013). Moreover, climate change perception is as an important element affecting the actual attitude towards adaptation actions and influencing climate change policy communication (Lorenzoni et al., 2005).

This paper presents the results of a survey on climate change perception; climate change beliefs and attitudes to adaptation that has been conducted among 1,024 Czech citizens, in October 2014.

The results of the survey show that the majority of the respondents (78%) agree with the fact that there is a global climate change. When it comes to adaptation measures, 51% of the respondents adopt a variety of individual actions (ranging from water saving to the insurance of their properties) that will be further discussed. It is mainly the young people (18 to 29 years) who have a positive attitude towards individual adaptation actions. Older people (40 years and over) with higher education prefer technical measures (such as flood protection of properties, installation of reservoirs for rainwater, etc.).

So far, the survey represents unique insights into climate change attitudes in the Czech Republic, which have not been investigated to this extent before. The results provided can support decision making regarding an adaptation policy, individual adaptation actions as well as the communication of climate change issues to a broader public.

References

European Commission (2013) An EU Strategy on adaptation to climate change. COM/2013/0216 final.
Lorenzoni I, Pidgeon N, O'Connor RE (2005) Risk Analysis 25, 1387–1398.

Acknowledgement

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Assessing the environmental risk of ecosystem service provision in the Czech Republic

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The purpose of this paper is to present a method for mapping the environmental risk associated with ecosystem service provision in the Czech Republic (Frélichová et al., 2014) based on a geographic information system (GIS). Among different modelling approaches, the proposed method combines basics from classical multi-hazard/ multi-dimensional risk assessments and vulnerability.

The approach is elaborated in respect to recent ecosystem service mapping at the national scale and in respect to important environmental drivers of ecosystem changes in the Czech Republic.

The results reveal clear spatial disparities in the distribution of hot-spots and cold-spots, based on the differential allocation of selected factors. The national case indicates that a future focus can be improved by a clearer connection of different ecosystem services and their respective drivers of change.

References

Frélichová J et al. (2014) Ecosystem Services 8, 110–117.

Acknowledgement

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Reliability of regional crop yield predictions in the Czech Republic based on remotely sensed data

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Remotely sensed vegetation indices by satellites are a valuable tool for vegetation condition assessment, also in the case of field crops. This study is based on the use of NDVI (Normalized Difference Vegetation Index) and EVI (Enhanced Vegetation Index) derived from MODIS (Moderate Resolution Imaging Spectroradiometer) aboard Terra satellite. Data available from the year 2000 were analyzed and tested for seasonal yield predictions within selected districts of the Czech Republic (Central Europe). Namely the yields of spring barley, winter wheat, and oilseed winter rape were assessed during the time period from 2000 through 2014. Yields observed in 14 districts (NUTS 4) were collected and thus 210 seasons were included. The selected districts differ considerably in their soil fertility and terrain configuration and they represent a transect across various agroclimatic conditions (from warm and dry to relatively cool and wet regions). Two approaches were tested: 1) using composite remotely sensed data (available in 16-day time steps) provided by the USGS (https://lpdaac.usgs.gov/); 2) using daily remotely sensed data in combination with originally developed smoothing methods. The yields were successfully predicted based on established regression models (remotely sensed data used as an independent parameter). In addition to other facts, the impact of severe drought episodes within the vegetation were identified and yield reductions were predicted at district level (even before the harvest). As a result, the periods with the best relationships between remotely sensed data and yields were identified.

The impact of drought conditions as well as normal or above normal yields of field crops could be predicted by the proposed method within the study region up to 30 days prior to the harvest. It could be concluded that remotely sensed vegetation condition assessment should be an important part of early warning systems focused on drought. Such information should be widely available to various users (decision makers, farmers, etc.) in order to improve planning, business strategies, but also to target the drought relief in case of a major drought event.

Acknowledgement

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Ecosystem services in the Šumava National Park: Impact of climate and land use change

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National parks present the most valuable and well-preserved natural areas. However, they have frequently been challenged by various anthropogenic and ecological pressures, and different preferences regarding their management regimes and future development. The Šumava National Park (NP) in the Czech Republic presents one of the most valuable mountain ecosystems in Europe, characterized by natural and semi-natural coniferous forests, peat mires and mountain meadows. It covers one of the largest forested areas in Central Europe, providing a wide array of ecosystem services and high biodiversity levels. However, at present the Šumava NP is threatened by various types of disturbances, including growing occurrence of extreme weather events and subsequent pest outbreaks, together with intensive tourism and increasing forestry demands. Therefore, the aim of this study was to (1) create an array of scenarios of future development in the study area, (2) identify potential local adaptation measures to climate change, and (3) evaluate the impact on local provision of ecosystem services and well-being. The methods of the study built on participative approaches and GIS modelling. First, the opinions and preferences of local stakeholders regarding future land use and land cover development in the study area were elicited at a scenario workshop. Based on the workshop results and localized climate change projections, we created a set of three future land use and land cover scenarios (Conservation, Development and Shared vision). Second, we identified potential adaptation measures applicable in the Šumava NP, corresponding with the storylines of different scenarios. Third, the impact of each adaptation scenario on the provision of ecosystem services was evaluated, with emphasis on regulating services such as climate regulation, water quality improvement and erosion control. Finally, a cost-benefit analysis of each adaptation scenario was conducted. The results of this study, indicating that the Conservation scenario brings the most substantial economic benefits, serve as the basis for the local process of adaptation to climate change, and provide an input to sustainable landscape management in the study area.

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The influence of land use change and landscape fragmentation on selected ecosystem service provisions

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Fragmentation can initially increase the landscape biodiversity, if species-rich ecotonal communities have been created between neighbouring habitats. If, however, the level of fragmentation significantly decreased the territories of key species below the subsistence area, the biodiversity decline can be apparent because it disrupts the whole food web. In addition, many organisms may be endangered by increasing road effective zones due to massive traffic. This may result in a reduced ecosystem function performance and a related ecosystem service provision.

The aim of our contribution is the analysis of the influence of land use change and landscape fragmentation in two small catchments (Všeminka, Fryštácký potok) in the forest-agricultural landscape of East Moravia (Czech Republic) on the carbon sequestration ecosystem service. The set of indices, describing a structure change and landscape fragmentation rate, were analysed from aerial photographs of 1953, 2005 and 2012 at the scale of 1:10 000. In addition, the land use/cover was verified from aerial photographs (in 2005 and in 2012 verified in the field). We used software ArcGIS 10.x with the help of extension Patch Analyst to calculate: i) length and density of the edges, ii) patch size change, iii) patch area to perimeter ratio, iv) change in fractal dimension and v) mesh effective size (Jaeger, 2000). According to the records of the national traffic census in 2010, the transport intensity and road width to the width of the disturbed habitat zone has been taken into account (according to Müller and Berthould, 1997). The effect of changes in land use, fragmentation and disturbed habitat zone area on carbon sequestration ecosystem service provision for each period was figured out. For this purpose the model InVEST was adapted and completed by the core area of the given landscape segment distinguishing (McGarigal et al., 2002) and the assignment of modified sequestration indices and transient zone estimations on the basis of the road-effect zone (Biglin, Dupigny-Giroux, 2006); all made in a vector space. In the catchment Všeminka the carbon sequestration increased slightly in both periods. In the catchment Fryštácký potok the carbon sequestration decreased slightly from 1953 to 2005, yet in contrast, it increased slightly from 2005 to 2012. The changes in fragmentation were not significant between 1953 and 2012. Therefore the changes in carbon sequestration were caused mostly by land use changes. The relationships between land use change, fragmentation and carbon sequestration from 1953 to 2012 are discussed.

References

Biglin K, Dupigny–Giroux A (2006) J. Conserv. Plan. 2, 1–16.
Jaeger JA (2000) Landscape Ecol.15, 115–130.
Müller S, Berthoud G (1997) Fauna/Traffic Safety. École Polytechnique Fédérale de Lausanne (LAVOC), Lausanne.

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2

ABSTRACTS OF POSTER PRESENTATIONS

Day-to-day air temperature change distributions and their relationship to passages of atmospheric fronts

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The aim of the study submitted is to describe the statistical distributions of day-to-day air temperature changes in Prague and to explain large interdiurnal changes (over 3 °C and 5 °C) by passages of atmospheric fronts. The following hypotheses are given: day-to-day air temperature changes are not distributed in a normal way, whereas large day-to-day temperature rises in winter are caused by passages of warm atmospheric fronts, and large interdiurnal cooling in summer are due to passages of cold atmospheric fronts. Minimum temperatures were used for the calculation of day-to-day changes in the winter period, whereas maximum temperatures were applied for summer period calculations. The hypotheses mentioned previously were verified by the Monte Carlo test.

The study results confirm all hypotheses. Distribution asymmetries of day-to-day temperature changes are influenced by passages of atmospheric fronts. This applies to both summer and winter periods. In addition, the study considers the replacement of maximum temperatures by measurements at 14:00 hours and minimum temperatures by measurements at 7:00. When using measurements at 7:00 hours, the results are almost the same. In case of 14:00 hours measurements, the findings are quite different.

References

Huth R, Kyselý J, Dubrovský M (2001) J. Climate 14, 4047–4061.

Surface-water temperature modelling for the estimation of the Czech fishery productivity under the climate change

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Freshwater fish production is significantly correlated with water temperature which is expected to increase under the climate change. This study is dealing with the estimation of the change of water temperature in productive ponds and its impact on the fishery in the Czech Republic. Calculation of surface-water temperature which was based on a three-day mean of the air temperature was developed and tested in several ponds in three main fish production areas. The output of the surface-water temperature model was compared with the data measured and showed that the lower range of model accuracy is the surface-water temperature at 3°C, below that temperature threshold the model loses its predictive competence. Expecting surface-water temperatures above 3°C the model has proved a good consistence between observed and modelled surface-water temperatures (R 0.79 – 0.96). The verified model was applied in the conditions of the climate change determined by the pattern scaling method, in which standardised scenarios were derived from five global circulation models MPEH5, CSMK3, IPCM4, GFCM21 and HADGEM. The results were evaluated with regard to thresholds which characterise the fish species requirements on water temperature. Thresholds used involved the upper temperature threshold for fish survival and the tolerable number of days in a continual period with the mentioned threshold surface-water temperature. The target fish species were Common carp (Cyprinus carpio), Maraene whitefish (Coregonus maraena), Northern whitefish (Coregonus peled) and Rainbow trout (Oncorhynchus mykis). The results indicated the limitation of the Czech fish-farming in terms of i) the increase of the length of continual periods with surface-water temperatures above the appropriate threshold to given fish species toleration, ii) the increase of the number of continual periods with surface-water temperatures above the threshold, both appropriate to given fish species toleration, and iii) the increase of the overall number of days within the continual period with temperatures above the threshold tolerated by given fish species.

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Soil moisture trends and their drivers in the Czech Republic between 1961 and 2012

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Soil moisture dynamics and their temporal trends in the Czech Republic are forced by various drivers. The methodology of applying remotely-sensed data with both high temporal and spatial resolutions provides detailed insight and objective quantification of the causes of changes in soil moisture patterns. Our analysis of temporal trends indicates that shifts in drought severity between 1961 and 2012 (especially in the April, May, and June period, which displayed a 50% increase in drought probability between 1961–1980 and 2001–2012) are alarming. We found that increased global radiation and air temperature together with decreased relative humidity (all statistically significant at the 0.05 level) led to increases in the reference evapotranspiration in all months of the growing season; this trend was particularly evident in April, May, and August, when more than 80% of the territory displayed an increased demand for soil water. This finding was shown to be consistent with the measured pan evaporation (1968–2012) that was characterized by increasing trends, particularly during the April–June period. These changes, in combination with the earlier stop of the snow cover and the earlier start of the growing season (up to 20 days in some regions), led to an increased actual evapotranspiration at the beginning of the growing season that tends to deplete the soil moisture earlier, leaving the soil more exposed to the impacts of rainfall variability. These results support concerns related to the potentially increased severity of drought events in Central Europe. The reported trend patterns are of particular importance with respect to the expected climate change, given the robustness and consistency of the trends shown and the fact that they can be aligned with the existing climate model projections.

Documentary evidence as a source of data for the study of droughts in the Czech Lands

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Information on past droughts can be derived from various types of documentary evidence used as basic data in historical climatology. This type of data represents an important source utilisable particularly for the pre-instrumental period. Direct reports of drought or indirect indications of its impacts can be found in various individual or institutional sources as narrative written sources (annals, chronicles, "books of memory"), weather diaries, personal and official correspondence, stall-keepers' and market songs, early journalism, financial-economic records, religious data (rogations, sermons, prayers), special printed sources, chronograms or epigraphic sources ("hunger" stones). Corresponding data inform us directly about meteorological droughts and with the description of drought impacts also about agricultural and hydrological droughts. The first credible direct drought information on the Czech Lands came from the Monk of Sázava and reported that there was no rain or snowfall during the winter of 1090/1091. Unfortunately, data before AD 1500 are rather scarce and they are prevailingly related to Bohemia. The density of precipitation/drought documentary records in the Czech Lands has been significantly increasing after 1500. This allows to create a series of precipitation indices with a classification of the dry months in the scale –1 (dry month), –2 (very dry month) and –3 (extremely dry month). Such datasets enabled the creation of the 500-year old Czech chronology of drought episodes.

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Documentary evidence as a source of information about past hydrometeorological extremes in South Moravia

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Hydrometeorological extremes (HMEs) represent destructive natural phenomena, which may often lead to great material damage or even loss of human life. In Moravia, systematic instrumental meteorological and hydrological observations began mainly in the latter half of the 19th century. To the past, knowledge about HMEs can be extended by investigation of the documentary evidence used in historical climatology and historical hydrology. In this paper, taxation records and family archives are used to extend existing information about HMEs in southern Moravia. Since the latter half of the 17th century, damage to buildings and land (fields, meadows, pastures or gardens) entitled farmers and landowners to request a tax relief. Documents related to this bureaucratic process are preserved at several levels (affected communities, regional offices, Moravian Land Office) and can be found in estate and family archives deposited in the Moravian Land Archives in Brno. Besides detailed information on damage, data related to the HME itself are often included as well, such as the time of occurrence, its course and impacts. Family archives themselves contain, in addition to the taxation data from estates belonging to the respective noble family, also some other documents related to HMEs, e.g. requests for help in affected regions, thank-you notes for such help, requests for loans for damage elimination. Based on the documents, a database of HMEs (floods, hailstorms, torrential rains, windstorms, droughts, late frosts) in South Moravia was created for the 17th–20th centuries. This database has recently been used for several analyses (e.g. floods, hailstorms), which will be presented (Brázdil et al. 2014a, 2014b).

References

Brázdil R, Chromá K, Řezníčková L, Valášek H, Dolák L, Stachoň Z, Soukalová E, Dobrovolný P (2014a) Hydrol. Earth Syst. Sci. 18, 3873–3889.

Brázdil R, Chromá K, Valášek H, Dolák L, Řezníčková L (2014b) Theor. Appl. Climatol. online, doi 10.1007/s00704-014-1338-1.

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Human impacts of droughts andother hydrometeorological extremes in South Moravia

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Droughts and other hydrometeorological extremes (HMEs, e.g. floods, hailstorms, torrential rains or late frosts) have always been an inseparable part of South Moravia. Natural disasters caused damage, affected human lives and influenced the behaviour and habits of the afflicted society. Documentary records related to farmers whose livelihoods were affected by droughts and other extremes in South Moravia in the 17th–20th centuries are used to study the impacts of natural disasters on the socio-economic situation of the farmers. Taxation records, damage reports, chronicles and official correspondence stored in the Moravian Land Archives in Brno as well as in other South Moravian district archives were analysed. The first flood event was reported on the River Morava in 1652. Extraordinary dry years have been documented since 1718 – in that year Dyje river totally dried up. Moreover, downpours, hailstorms, windstorms, late frosts and blizzards also caused great damages during the periods studied and had negative effects on human society in many cases. The impacts of HMEs are classified here into three categories: agricultural production, material property and the socio-economic situation of the individual farmers. Direct impacts took the form of losses of property, supplies and farming equipment, and further the form of bad fields and fruit yields, depletion of livestock, damage to fields and meadows, lack of water for daily use, watermills and transport and an increased threat of wildfires. The simple lack of income, debt, impoverishment, reduction in livestock and deterioration in field fertility were among the longer-term effects. Impacts are discussed with respect to approaches to mitigation of the negative effects of HMEs and to problems associated with obtaining support and also in terms of a hierarchy of consequent impacts. A great number of records related to natural disasters represents a rich source of data allowing re-discovering of historical natural disasters. This paper embodies a methodological approach that is intended for the analysis of HME impacts in South Moravia from the 17th through the 20th centuries.

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Climate projections for the Czech-Saxon border region until 2100
(INTERKLIM project results)

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The climate conditions in the Czech Republic and the German federal state of Saxony are crucially shaped by the orographic conditions in the border area. Particularly, the location and exposure of the Ore Mountains has a major effect on the incoming air mass (windward and leeward) and significantly modifies the climate characteristics in both countries. Thus, different large-scale atmospheric circulation patterns can have entirely different impacts on the local climatic conditions in those two different regions. Both the geographic heterogeneity and the expected climate change and its associated risks, pose the challenge to develop cross-border and integrative adaptation strategies against the climate change. The development of such strategies is dependent on the availability of adequate data sources and expert knowledge. Therefore the main objectives of the project INTERKLIM are the joint transnational climate cooperation, particularly data exchange, analysis and the creation of regionally specific climate projections for the naturally complex border region on the base of up-to-date scientific data and methods. The obtained results represent a working base for a large number of urgent questions in the field of climate impact research and climate adaptation for various stakeholders (e.g. in agriculture, forestry, fishery, water management, spatial planning, tourism, health, nature conservation, or for the identification of adaptation needs and adaptation capacity). The outcome of the project can be consulted to support the emerging development processes for transnational adaptation strategies and they are implemented by stakeholder events, outdoor information panels on climate change in the border region, publications and additional public relations measures. Thus, the results can contribute to both the public discussion and the professional identification of both potential synergies and conflicts in a wide range of sectors.

In this contribution, we specifically focus on results of climate modelling in the region. Further information on the project results, e.g. various impact studies, may be found on the project web page (http://www.interklim.eu/).

Köppen-Geiger climate classification by different Regional Climate Models according to A1B SRES scenario in 21st century

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Abstract

Regional Climate Models (RCMs) and Global Circulation Models (GCMs) are state-of-the-art tools employed for climate change and variability research as they are designed to capture climate evolution based on direct physical modelling of atmosphere, ocean and other components of climate system on both global and regional scale. In our paper, we investigate projected future climate obtained as a result of high resolution climate simulation performed with selected combinations of more GCMs and RCMs forced by emission scenario A1B as defined in Special Report on Emission Scenarios. Köppen-Geiger climate classification was utilized as a diagnostic tool as this classification was derived directly from eco-biological vegetation characteristics in individual regions of Earth and so is suitable to assess the climate change impacts on ecosystems. Köppen-Geiger climate subtypes were predicted in 2025-2050 and in 2070-2100 time slices compared with observed climate types in 1961-2000. Area covered by warmer climate types is increased by each RCM for the future but the degree of their extension is different among them. These differences come from the different GCMs application as a driver, different physical package of RCMs, different resolution and representation of natural variability in individual models. The difference of resolution plays rather minimal role in the differences. The physical package control the radiation, cloudiness, surface properties such as soil thermal and moisture capacity and conductivity. These properties evolution has also a significant effect on the climate prediction (but to smaller extent than the driving GCM data). Due to the underestimated sea-ice, the cold winters are caused by advected cold air from the Artic owing to NAO blocking pattern alteration during solar minima and higher natural variability is denoted by r3 in ECHAM5-r3 GCM driver results cooler climate projection in ICTP, KNMI and SMHIRCA models than CNRM, DMI and ARPÈGE ones which are downscaled from ARPÈGE GCM.

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The influence of variable weather on the incident solar radiation and its spectral composition in the Ostrava region, Czech Republic

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Incident solar radiation is influenced by many factors, specifically by distance from the equator, altitude, time of year and season (Paul & Gwynn-Jones, 2003). The absorption of radiation and its scattering are connected with properties of atmospheric compounds (Bohren & Huffman, 2004). Cloud cover (Oliphant et al., 2011) and air pollution (Moosmüller et al., 2009) are connected with tropospheric properties. A higher proportion of diffuse radiation reaches the ground during cloudy days, compared to a higher proportion of direct radiation during sunny days (Nann & Riordan, 1991).

Solar radiation components are measured by a system of sensors located in the Botanical Garden of the University of Ostrava (GPS 49°9.64873'N, 18°9.56197'E). This includes sensors for the phytochrome ratio (660/730 nm), UVA and UVB radiation, total solar radiation energy in the range of 400 and 1100 nm (global energy of radiation), interval measurements in the wavelengths 400–700 nm (photosynthetically active radiation – PAR), 510–700 nm and 600–700 nm. Spectral bands of PAR – blue (400–510 nm), green (510–600 nm) and red (600–700 nm) – are calculated from these interval measurements.

Using these data, the influence of changes in the weather on the received dose of spectral irradiance and its spectral composition are described. Days were divided into sunny and cloudy day categories according to the weather conditions and daily radiation patterns. Percent differences in solar radiation received between sunny and cloudy days were calculated in eight months of the year 2014 (Jan, Feb, Mar, Jun, Jul, Aug, Sep, Dec). Differences in solar radiation received between clean and polluted days were calculated for December 2014. The average incident solar radiation during cloudy days was reduced to 39 % of the value for sunny days (during summer months) and to 36 % of the value of sunny days during winter months. The highest influence of clouds on solar radiation received was during September. On the other hand, the lowest influence of clouds on this pattern was during June. In December, the average difference between incident solar radiation during clean and polluted sunny days was 10 % and the average difference between incident solar radiation during clean and polluted cloudy days was 21 %.

As we progress through these analyses, we intend to use models for the comparison of incident solar radiation and make more detailed statistical analysis of these relationships.

References

Bohren CF, Huffman DR (2004) Absorption and Scattering of Light by Small Particles. Wiley-VCH, Weinheim. ISBN 0-471-29340-7

Moosmüller H et al. (2009) J. Quant. Spectrosc. Radiat. Transfer. 110, 844–878.

Nann S, Riordan C (1991) J. Appl. Meteorol. 30, 447–462.

Oliphant AJ et al. (2011) Agr. Forest Meteorol. 151, 781–791.

Paul ND, Gwynn-Jones D (2003) Trends Ecol. Evol. 18, 48–55.

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Global solar radiation: comparison of satellite and ground based observations

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We analysed monthly and annual values of downwelling solar shortwave fluxes supplied by the EUMETSAT Land Surface Analysis Satellite Applications Facility (LandSAF) from that data measured by the SEVIRI instrument on the operational MSG satellite (MSG-2 and MSG-3) in the year 2013. The satellite LandSAF data are evaluated against ground measurements of global solar radiation carried out on 17 meteorological stations of the Czech Hydrometeorological Institute. We tested our validation approach by taking either the closest satellite grid box to a station, or a group of neighbouring satellite grid boxes were spatially averaged and then we calculated the error characteristics. Our aim is to find out, whether and how the LandSAF shortwave radiation data on monthly to annual time scales can stand for the high quality ground measurements in the climate conditions of Central Europe and thus potentially serve as an alternative source of information on the global solar radiation outside of meteorological station networks.

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The quality of inland waters – airborne mapping of cyanobacterial occurrence

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Water is considered as an essential substance on the Earth. Many of the natural or human induced processes are closely related to some water quality requirements. Phytoplankton (cyanobacteria and algae) water blooms (Chorus et al. 2000) represent one of the most serious issues related to water quality. Massive water blooms occur in many freshwater lakes, slow-running rivers and shallow coastal water due to anthropogenictrophication (Paerl and Paul 2012) . Standard methods of phytoplankton quantification are based on laboratory microscopic analyses and complementary spectroscopic assessment of chlorophyll concentration, and eventually on in-situ measurements of induced chlorophyll fluorescence. Remote sensing may offer more effective and spatially precise methods for monitoring a cyanobacterial occurrence.

In this study we illustrate a possible application of airborne imaging spectroscopy to map spatial the distribution and concentration of cyanobacteria in inland waters. The Brno water reservoir (49.2414756N, 16.5064217E) was selected as a model water body known for its high concentration of cyanobacteria.

Airborne hyperspectral (AISA Eagle) images of the Brno water reservoir was acquired in September 2013. Complementary in-situ spectral measurements (ASD FieldSpec) and water sampling (YSI probe) were carried out from a boat during the airborne data acquisition. Concentrations of chlorophyll (Chl) and phycocyanin (Pc) were measured in the water samples. Chl and Pc are optically active pigments that are typically used to distinguish between algae and cyanobacteria.

We used an empirical approach based on two selected spectral indices (R700/R675 and R700/R600) which are sensitive to a chlorophyll (Vinciková et al., 2013) and phycocyanin (Mishra et al. 2009) concentration, respectively. The model was calibrated on field spectral measurements and consequently applied on the airborne hyperspectral image.

The results document: 1/Statistically significant correlations between spectral indices and concentrations of chlorophyll and phycocyanin, respectively; 2/Chl and Pc concentrations estimated from the airborne hyperspectral data display a similar spatial pattern as a result of the chlorophyll presence in both organisms (algae and cyanobacteria).

The achieved accuracy of the index sensitive to Chl concentration corresponds well with the results presented by. Vinciková et al. (2013).

The accuracy of the Pc model was lower than that Mishra et al. (2009).. This discrepancy could be related to other factors (water turbidity, dissolved organic matter or contamination of the water leaving the radiance signal by the surrounding vegetation) that could negatively influence our field spectral measurements.

The selected approach showed that airborne imaging spectrometry can be used for the assessment of cyanobacterial occurrence in inland waters. Nevertheless, other methods, such as radiative transfer modeling, can perhaps provide more reliable estimates of Chl and Pc concentrations because they can also account for other optically active water constituents.

References

Chorus I et al. (2000) Journal of Toxicology and Environmental Health, Part B 3, 323–47.

Mishra S et al (2009) Remote Sensing 1, 758–75.

Paerl HW, Paul VJ (2012) Water Research 46, 1349–63.

Vinciková H, Pechar L, Hanuš J (2013) Měření a Využití Spektrální Odrazivosti (reflektance) Slunečního Záření Z Hladiny Povrchových Vod.

Data sources for a tree crown segmentation process — laser scanning versus hyperspectral imagery — methodological differences

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A tree crown segmentation process provides detailed information on the structure of a forest. It requires remotely sensed input data of a sufficient spatial resolution (Leckie et al. 2003). This study compares different data sources for an automatic process of tree crown segmentation. The two principally different possibilities are airborne laser scanning (ALS, active remote sensing) and hyperspectral optical imagery (HS, passive remote sensing).

The acquisition process is compared with respect to mapping the forest canopy structure. The data source influences the segmentation workflow, both in the detection and delineation phase. The differences in algorithms and settings are analysed for the ALS and HS data. The results are evaluated on a common data set from the Bily Kriz region (Beskydy Mts., Czech Republic) and discussed with respect to aboveground biomass estimation. (Brovkina et al. 2014) Finally, a combined use of both data sources is recommended.

References

Brovkina O, Novotny J, Zemek F, Russ R, Cienciala E (2014). Mapping aboveground tree biomass using airborne data: a case study in the Beskydy Mountains. Submitted in: International Journal of Remote Sensing.

Leckie D, Gougeon F, Hill D, Quinn R, Armstrong L, Shreenan R (2003). Combined high-density lidar and multispectral imagery for individual tree crown analysis. Canadian Journal of Remote Sensing, 29, 633–649.

Oak response to the climate in Slovakia investigated by recent TRW chronology

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The territory of Slovakia was the only one in Central Europe for which an independent oak tree-ring-width chronology had not been created. Therefore, the main objective was to create a well replicated oak TRW chronology and to use the chronology for testing the oak climate sensitivity in the region. Samples were randomly taken at numerous sawmills and from living trees all over the country. The Slovakian oak chronology consists of disc and core samples of 948 oaks spanning the period from 1717 through 2012 AD. The results confirm that the resemblance of TRW chronologies decreases with an increasing distance of the plots. This trend is also obvious when the chronology is compared with the other Central European oak chronologies. Growth-climate relationship reveals the significance of spring and early summer precipitation and PDSI, especially between February and the end of the growing season. The newly established recent TRW chronology forms a basis for a potential long oak chronology creation from historical material in the region, which can then be used for climatic reconstructions.

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Using remotely measured PRI to characterize the functioning of the boreal forest: theory and practice

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The Photochemical Reflectance Index (PRI; Gamon et al., 1992) of green leaves is an indicator of photosynthetic downregulation: when the photosynthetic apparatus is close to the saturation limit, PRI becomes dependent on light conditions. This happens, for example, to the most exposed leaves or needles in a forest canopy on a clear, sunny day. A positive relationship between PRI and light use efficiency (LUE) is expected: an increase in the former should indicate an increase in the latter. Therefore, remote monitoring of forest PRI can supply information on the status of the photosynthetic apparatus of the forest, and thus its LUE. However, the value of leaf PRI varies with canopy location (sun or shade) and is thus a strong function of view geometry. The dependence of canopy PRI and shadow fraction can, in theory, be used to determine the LUE of a vegetation canopy from multiangular remote sensing data (Hilker et al., 2010).

The strong correlation with the shadow fraction and scatter angle was confirmed in a time series analysis of EO-1 Hyperion remote sensing data obtained over the Hyytiälä Scots pine site in central Finland, southern boreal zone. However, the correlation was the opposite of what had been expected from theory and leaf-level measurements. Additionally, we show that the dependence of canopy PRI on shadow fraction is affected – in addition to photosynthetic downregulation – by the blue sky radiation caused by Rayleigh scattering in the atmosphere. To quantify this effect on remotely sensed PRI, we present the underlying definitions relating to leaf and canopy PRI. We performed the calculations required to transform forest PRI to needle PRI in the Hyperion time series data, but could not explain the measured PRI variation. Finally, PRI is known to depend on the composition of the canopy pigment pool (Porcar-Castell et al., 2012). Although the pigment data measured at Hyytiälä in 2009 do not show any seasonal trends similar to that in Hyperion-derived PRI, the possible connections between needle pigment pool composition and PRI need further investigation.

References

Gamon J, Penuelas J, Field C (1992) Remote Sens. Environ. 44, 35–44.

Hilker T, Hall FG, Coops, NC, Lyapustin A, Wang Y, Nesic Z, Grant N, Black TA, Wulder MA, Kljun N, Hopkinson C, Chasmer L (2010). Remote Sens. Environ. 114, 2863–2874.

Porcar-Castell A, Garcia-Plazaola JI, Nichol CJ, Kolari P, Olascoaga B, Kuusinen N, Fernández-Marn B, Pulkkinen M, Juurola E, Nikinmaa E (2012) Oecologia 170, 313–323.

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Validation of remotely sensed fPAR in a boreal forest site

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The fraction of absorbed photosynthetically active radiation (fPAR) is a key variable determining water, carbon and energy exchange between land surfaces and the atmosphere. Satellite-based remote sensing methods for fPAR developed fast during the past decade. However, there is a scarcity of ground-based estimates of fPAR, especially from boreal forests, which limits the development of the satellite-based fPAR products. The aim of this study was to validate two globally available fPAR products – MODIS fPAR and GEOV1 fPAR, and to study the spatial and temporal characteristics of the products in a boreal site. In addition, we tested how well the Normalized Difference Vegetation Index (NDVI) approximates fPAR in a boreal forest, because NDVI data are available more often and with different spatial resolutions compared to the satellite-based fPAR products. The NDVI-fPAR relationship was tested using data with two different spatial resolutions: the MODIS surface reflectance product (0.25 × 0.25 km) and a Landsat 8 (0.03 × 0.03 km) image. Our ground reference data were collected at a boreal forest site located in Hyytiälä, Finland (61˚50´N, 24˚17E) between June 24th and August 29th 2013. The size of the study area was 16 km2 and consisted of 307 forest plots, where intensive measurements of both forest canopy and understory were conducted. The ground reference fPAR was modelled based on a recently developed canopy absorption model (Stenberg et al., 2013), which uses measured canopy transmittance data (i.e., is applicable with different field instruments (Majasalmi et al., 2014)) and spectra of foliage and understory. In this study, we used a separate model for understory fPAR. Thus, we had two different ground reference estimates of fPAR: forest canopy fPAR and total fPAR consisting of both tree canopy and an understory fPAR. Results showed that GEOV1 fPAR was more similar to ground reference total fPAR whereas MODIS fPAR corresponded better with forest canopy fPAR i.e., it excluded the understory fPAR. The temporal behavior of GEOV1 fPAR was smooth compared to MODIS fPAR probably due to a larger number of good quality retrievals compared to MODIS fPAR. The fPAR values derived using the NDVI-fPAR relationship were not similar for the two different data sets: MODIS surface reflectance based estimates of fPAR were similar to ground reference total fPAR, but the Landsat 8 based estimated of fPAR were more similar to forest canopy fPAR.

References

Stenberg P et al. (2013) Remote Sens. Environ. 137, 12–16.

Majasalmi T et al. (2014) For. Meteorol. 189–190, 118–124.

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Preliminary results of the improvement of temperature and emissivity separation algorithm

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The spectral response recoded by a remote sensing instrument in the thermal range depends on the temperature and emissivity of an observed object. Computation of these quantities is mathematically unsolvable since the temperature, as well as the emissivity in each spectral band are unknown. Therefore, different empirical approaches of temperature and emissivity estimation were developed. One of the most widely used approaches is the Temperature and Emissivity Separation (TES) algorithm, which was originally developed for ASTER images. Nowadays, it is applied to various multispectral and hyperspectral thermal data. The objective of this work is to improve the TES algorithm. The main modification is the substitution of the Normalized Emissivity Method (NEM) module by a new module, which is based on the smoothing of spectral radiance signatures. Smoothing is performed by estimating the emissivity using the optimal relationship between brightness temperature and emissivity. The improved TES algorithm was tested on simulated data of different sensors (ASTER, AHS and TASI). The results showed more accurate retrievals of temperature and emissivity because the error variance is significantly reduced in comparison with the original algorithm. This may imply that spectrally homogeneous areas exhibit lower noise in temperature and emissivity retrievals. Accurate maps of land surface temperature and emissivity are required for applications, such as energy balance, evapotranspiration, mineral mapping, urban studies and many others.

References

Gillespie A, Rokugawa S, Matsunaga T, Cothern JS, Hook S a Kahle AB (1998) A temperature and emissivity separation algorithm for Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) images. IEEE Transactions on Geoscience and Remote Sensing 36(4), 1113–1126.

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Optimization of 3D spruce shoot representation for forest radiative transfer modelling

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Canopy radiative transfer models (RTMs) are computer programmes simulating interactions between canopy elements and incident light. Since they provide a physical link between canopy biochemical and structural properties and canopy reflectance, they are being used to interpret remote sensing (RS) data for vegetation properties (Jacquemoud et al. 2009). However, interpretation of RS data of coniferous forests can be a challenging task due to the complex canopy and shoot architecture that significantly modulates forest light scattering, particularly in the near infrared spectral domain.

In this study we used canopy Discrete Anisotropic Radiative Transfer (DART) model (Gastellu-Etchegorry et al. 2004), which allows simulating complex 3D forest canopies such as Norway spruce (Picea abies /L./ Karst.) scenes. At this moment, DART uses three different approaches for simulating trees and their foliage. The first is a simplified tree model with foliage represented as homogeneous turbid medium cells. The second is a 3D tree model that is automatically converted by DART into a distribution of turbid cells that retains the original tree crown architecture. The third is an explicit 3D model of a tree, where foliage is represented by facet-based leaves. Naturally, the last approach is the most accurate and suitable for needle-leaf trees, but also most computationally demanding. The objective is to optimize the simulation of coniferous trees in DART by proposing several simplifications of 3D shoot representations that are computationally effective and still able to reassemble sufficiently the light scattering properties of conifers.

We tested three 3D geometrical representations of Norway spruce shoots. In the reference case, needles within a shoot were constructed as individual 3D objects. The other three evaluated cases were progressive generalizations of the reference shoot. Bidirectional reflectance factors (BRF) of all three shoot models were simulated under varying solar azimuth and zenith angles and several viewing angles and consequently cross-compared to assess their similarities and deviations.

Preliminary results show that one of the simplifications provides a BRF comparable to the reference shoot. This would allow simulating significantly larger scenes of needle-leaf forests representing more realistically real satellite observations.

References

Jacquemoud S, Verhoef W, Baret F, Bacour C, Zarco-Tejada PJ, Asner GP, Francois C & Ustin SL (2009) Remote Sensing of Environment 113, S56–S66.

Gastellu-Etchegorry JP, Martin E & Gascon F (2004) International Journal of Remote Sensing 25, 73–96.

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Evaluation of the remotely sensed vegetation start related to phenology observations of winter wheat and spring barley in the Czech Republic.

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Various phenology metrics of agricultural crops are important characteristics that have been monitored at the ground station by the meteorological service in the Czech Republic for a long time already. The financial demands of this method require looking for other solutions. Satellite observations enable monitoring of the ground vegetation at a sufficient resolution, both at a local and regional scale. However, ground and remote sensing phenology differ in the nature of their objects. The first is focused on single species and limited individuals at the observation spot. By its definition remote sensing is able to monitor vegetation communities covering a large area. To understand the differences of phenology metrics derived by both methods mentioned here is one aim of the study. In order to achieve this, we tested different methods for filtering of the satellite signal and settings for the start-of-the-season derivations.

Our study area covered the Czech Republic with a typical four season temperate climate that strongly influences the vegetation and its remotely sensed signal. Daily MODIS (Moderate Resolution Imaging Spectroradiometer) remote sensing data in 250 by 250 meters of resolution were used to compute NDVI (normalized difference vegetation index). The filtering of the data is crucial for overcoming missing periods, mainly due to atmospheric conditions (cloudy weather) and weak vegetation signals during winter (fewer green plants). An iterative method was developed and used for filtering the NDVI time series from the year 2000 up to now. From the improved curve of NDVI the start of the season was derived as an absolute threshold value at different levels.

We made a comparison of the remotely sensed start of the season with observations of the emergence of spring barley and the beginning of the leaf sheath elongation for winter wheat. The data were correlated at 90 meteorological ground stations across the Czech Republic from the years 2000 through 2012. Correlations at the original 250 x 250 meters of resolution and aggregations of 5 x 5 km were investigated. Different land covering classes were taken into consideration for aggregated areas.

The correlation with the start of the season is lower for spring barley as a result of the strong influence of the winter signal and the farmers' onset of crop sowing. The best correlation results were achieved in aggregated areas for winter wheat on agricultural and arable land. Our evaluation verified the potential of remotely sensed data to provide wide area information on vegetation dynamics. However, phenology focused on a particular site or species requires a fine-tuned derivation process for locally specific investigations.

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Flux footprints in different ecosystems

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Flux footprint is an upwind area where atmospheric flux measured by an instrument is generated. The size of the footprint depends on the measure height, surface roughness, and atmospheric thermal stability.

Our study is focused on flux footprints of Czechglobe eddy covariance sites: wetland, grassland, agroecostystem, young and mature spruce forests. Our aim was to compare flux footprints under different atmospheric thermal conditions – stable, neutral and unstable. Two models were used for computing – the Kormann-Mexiner model (2001) and the Kljun model (2004). The outputs were processed graphically in site maps.

References

Kormann R, Meixner FX (2001) Bound-Lay Meteorol. 99, 207–224.
Foken T, Leclerc MY (2004) Agr. Forest Meteorol. 127, 223–234.
Kljun N et al. (2004) Bound-Lay Meteorol. 112, 503–523.

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The Bowen Ratio/Energy Balance method and detailed temperature profile measurements for the improvement of data quality check

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Water plays a key role in the functionality and sustainability of ecosystems. In light of the predicted climate change research should be focused on the water cycle and its individual components. Apart from the runoff, the major component of the water balance which drives water from the ecosystems is represented by the evapotranspiration (ET). One of the standard methods for measuring ET is the Bowen Ratio/Energy Balance method (BREB). It is based on the assumption that water vapour and heat are transported by identical eddies with equal efficiency. In fact, this basic premise is based on a more complicated Monin-Obukhov similarity theory that explains the relationship between the profiles of wind, temperature and water vapour in the surface layer of the atmosphere. When the BREB method is used we assume that the profiles of temperature and air humidity are ideally logarithmic or at least consistent. However, as this method is usually based on the measurements of temperature and humidity at only two height levels, it is difficult to verify this assumption.

We therefore conducted a field experiment using a 4m tall measurement mast with 20 thermocouples connected to a data logger for a detailed measurement of the air temperature profile above different covers, e.g. grassland, spring barley, poplar plantation. The main goal of our effort was to capture the so called "kink" in the temperature profile and verify if the assumptions made by BREB hold under various weather conditions and over different canopies, testing the basic requirements of the BREB method. Finally, we devised a technique improving data selection for a subsequent ET calculation.

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Atmospheric Station Křešín u Pacova – a central European research infrastructure for studying greenhouse gases, aerosols and air quality

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Climate, meteorology and atmospheric chemistry are scientific disciplines for studying the same system: the atmosphere. Therefore, long-lasting research infrastructures covering all three areas are of highest importance in the current, changing world. The Atmospheric Station (AS) Křešín u Pacova serves as a monitoring point for the measurement of concentrations and long-range transport of greenhouse gases, atmospheric aerosols, gaseous pollutants and basic meteorological characteristics. It mainly consists of a 250 m tall atmospheric tower equipped with meteorological sensors, gas and aerosol analysers, and a flask sampling system. Additional instruments are placed in a ground based container. The station aims to become a Level 1 Station of the Atmospheric Station Network under the Integrated Carbon Observation System (ICOS) ensuring long-term (20 years and more) monitoring of greenhouse gases in Europe. The AS also provides monitoring data to numerous other international and national databases (EMEP, GAW, InGOS, GMOS, ACTRIS, ISKO). The AS is located adjacent to the Košetice Observatory specialized in air quality, meteorological and hydrological monitoring activities since 1988. Both infrastructures form the co-located Station Košetice – Křešín u Pacova.
The first measurements at the AS Křešín u Pacova started in 2012. Tests concerning the instrument performance, optimization of the sampling setup and adjustment of quality assurance and quality control procedures were conducted. A first insight into the measured parameters, vertical gradients and the structure of corresponding datasets was obtained, too. This knowledge is substantial for high quality monitoring at the site.

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Air flow characterization of the Atmospheric Station Křešín u Pacova

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The measurements at the Atmospheric Station (AS) Křešín u Pacova are carried out at several levels of the 250 m tall meteorological mast (tall tower) and they are focused on the determination of greenhouse gases and other pollutant concentrations in the atmosphere. For a clear interpretation of the data obtained and their correct statistical evaluation it is necessary to characterize this site in terms of wind field and turbulent vertical mixing of the air. For this purpose a detailed analysis of wind directions via the calculation of wind roses and prevailing wind directions was made over a time period of 35 years on the basis of the ERA/Interim reanalysis data. A very important question is whether we can expect the same wind conditions at different periods of the year. Therefore, the analysis was focused not only on the annual average, but wind roses for individual seasons were calculated as well.

The footprint of the tall tower is comprised by the basic characteristics of potential source areas of measured compounds, based on airflow data. For the most general characterization the selection of the year with the most typical air flow has been made and for that year a footprint was calculated. An important selection criterion was the representativeness over a long period of time but the choice was also strongly influenced by the availability of data that can be used for calculation. On the basis of those conditions the year 2011 was selected and a footprint was calculated using the STILT program (Lin et al. 2003).

To understand the concentration variability of substances during the day in various seasons the description of the vertical turbulent flux of the air and the resulting atmospheric boundary layer dynamics is also important. To determine the height of the atmospheric boundary layer the Vaisala CL-51 ceilometer was installed at the station in December 2014. These observations will provide important information for a deeper understanding of the concentration gradients measured at the mast.

References

Lin JC et al. (2003) J. Geophys. Res. 108, D16, 4493.

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Statistical evaluation of half-year co-located measurements of gaseous elemental mercury

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The only regular continuous monitoring of gaseous elemental mercury in ambient air in the Czech Republic is performed at the Atmospheric Station Křešín u Pacova. Two analysers TEKRAN 2537B are used for the measurement of mercury concentrations at this station. The presentation deals with the evaluation of measuring the concentrations of gaseous elemental mercury from those analysers, positioned right next to each other in one ground-based container. The dataset has a 10 min time step and measurements were conducted between December 2012 and June 2013. This measurement campaign was aggregated into shorter time periods, approximately weekly intervals. Individual measurements obtained from both devices were graphically visualised and evaluated by using exploratory data analysis. The dependence of values measured by the second device on the values from the first device was examined. The pairs of measurements reported a linear trend in all the monitored periods. Thus, these measurements were always fitted by the regression line for individual time intervals. The aim of this presentation is to find time periods in which pairs of measurements correspond the most. For this purpose, cluster analysis of regression coefficients was applied with the use of appropriately selected criteria. The results of this analysis indicate the existence of five periods in which the regression lines show certain similarities. Further attention is paid to the analysis of individual homogeneous periods.

References

Stankovičová I, Vojtková M (2007) Viacrozmerné štatistické metódy s aplikáciami. 1. vyd. Bratislava, Iura Edition. 261 s., ISBN 9788080781521.

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Agricultural drought and remote sensing

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Wilhite and Glantz (1985) categorized four basic approaches to the drought definition: meteorological, agricultural, hydrological, and socioeconomic. The first three approaches deal with measuring a drought as a physical phenomenon. The drought monitor system for the Czech Republic, released in 2012, uses daily meteorological data as well as information on soil properties, land use and digital terrain model to assess agricultural droughts. It is based on a daily step calculation of soil moisture (Hlavinka et al., 2011) for the whole area of the Czech Republic (e.g. Trnka et al., 2013), divided into regular grids with a spatial resolution of 500 m. The results are published on the weekly operated webpage (www.intersucho.cz). Using freely available data from the MODIS (Moderate Resolution Imaging Spectroradiometer instrument onboard Terra satellite) the vegetation state is taken into account as a support tool for vegetation drought impact assessment. Based on the surface reflectance bands the Normalized Difference Vegetation Index (NDVI) is calculated. Consequently, a weekly NDVI anomaly is expressed as Percent of Average Actual Greenness (PAAG) in relation to the average for the period of 2000-2014. The system contains filter algorithms that eliminate the noise, mainly due to cloud effects, in the satellite NDVI data. The following operation allows for changing crop patterns between seasons and aggregate filtered values to a 5x5 km resolution with regard to the main land use categories. The aim of this study was to compare the satellite based vegetation conditions to the results of soil moisture calculation in order to detect the impacts of droughts on vegetation during seasons with low and normal precipitation.

References

Hlavinka P et al. (2011) Agriculture and Water Management 98, 1249–1261.
Trnka M et al. (2013) Climatic Change 120, 405–418.
Wilhite DA, Glantz MH (1985)Water International10, 111–120.

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Dendrochronology of Abies spectabilis in western Nepal

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Treeline species are considered sensitive biomonitors of the climate change. Trees growing in the forest line can respond to the atmospheric warming either by shifting to a higher elevation or by densification of the existing forest. This study was carried out to develop the ring-width chronology of Abies spectabilies from Humla, Western Nepal and to examine the climatic signal recorded by the annual rings. Eighty paired samples of 40 trees were collected, the annual ring width was measured using the 0.01 mm accuracy LINTAB measurement system, measurement and cross dating were then examined using the COFECHA program. A ring-width chronology of 270 years was developed dating back to 1742 AD based on the 40 dated series of A. spectabilis. The average radial growth was 0.83mm/yr. The values of mean sensitivity were 0.103 and 0.128 for standard and residual chronologies, respectively. The climate growth relationship revealed that seasonal climatic intervention was more dominant in the radial growth of A. spectabilis in that region compared to an individual, monthly climatic influence. The total precipitation of the monsoon period, i.e. July, August and September, had a positive relationship with the annual ring-width of A. spectabilis. In conclusion, the preliminary analyses showed that A. spectabilis may be a good species for a climate reconstruction over several hundred years.

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Orchids of Nepal: phytogeography and economic importance

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Nepal is in a biogeographically unique location with a wide variation in elevation from tropical to nival regions in the south-north direction. There is a high diversity of vegetation, not only in the north-south direction but also in the east-west direction. To understand the phytogeography of Nepal, an analysis of the most diverse group of angiosperms, orchids, was carried out. The analysis included the recently published complete list of Nepal's orchids. Each taxon was assigned to a specific phytogeographical region based on its present distribution. To assess the floristic affinities between different regions Krober's percentage similarity was also calculated. The orchid flora consists of 476 taxa known from Nepal belonging to 107 genera, 454 species, and 22 intrageneric taxa. The East Asiatic floristic region (EAFR) represented the highest number of (275 species, 57.77%) followed by the Indo-Chinese floristic region (ICFR) (261 species, 54.83 %), and the Malesian floristic region has (78 species, 16.39 %). In total, 118 (24.73%) were Himalayan endemics and 21 species Nepal endemics. Krober's percentage similarity showed that EAFR and ICFR have the highest percentage similarity (87.00%) followed by the Malesian floristic region and ICFR (62.44 %). In total, 92 species were used as medicinal and seven as food plants in Nepal. It was concluded that Nepal is rich in orchid flora, mostly represented by East Asiatic floristic elements and many species are ethnobotanically important.

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Determinants of orchid species diversity

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Currently there are studies which suggest that the number of orchid species on islands is except their size and latitude also positively correlated with their connectivity on other islands. This may be due to the fact that higher locality connectivity means also higher colonization probability of a new species thanks to higher probability of species seed dispersal. This dependence could apply also in a smaller scale within a single continent or country, but this has not been tested so far (Schödelbauerová et al. 2009).

Probability of occurrence of a single orchid species on locality can be also affected by the history of locality (Janečková et al. 2006). On sites unaffected by human (by ploughing or fertilization) it is possible to expect a higher probability of occurrence of a single orchid species than on anthropogenic sites. The effect of anthropogenic influence can decline in time because the locality can return to natural state and can be recolonized from surrounding living populations again. The effect of these opposing opinions on the orchid occurrence is not known.

The aim of this study is, with the aid of existing historical and recent databases of terrestrial orchid species occurrence on a selected area, to test the following hypothesis:
1) The probability of occurrence of a single terrestrial orchid species depend on connectivity of selected locality.
2) The probability of occurrence of a single terrestrial orchid species depend on history of selected locality.

First we will start in South Bohemia area with the first five most abundant species. Maybe we will be able to extend the study area and species to whole Czech Republic, alternatively to foreign countries.

References

Janečková P, Wotavová K, Schödelbauerová I, Jersáková J, Kindlmann P (2006) Biological Conservation 129, 40-49.
Schödelbauerová I, Roberts RL, Kindlmann P (2009) Biological Conservation 142, 2329–2334.

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Possible impact of climate change on European wetlands

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The present area of European wetlands is only a fraction of their area before the start of a large-scale human colonization of Europe. Many European wetlands have been exploited and managed for various purposes. Large wetland areas have been drained and reclaimed mainly for agriculture and the establishment of human settlements. These threats to European wetlands persist. The main responses of European wetlands to ongoing climate changes will vary according to wetland type and geographical location. A sea level rise will probably be the decisive factor affecting coastal wetlands, especially along the Atlantic coast. In the boreal part of Europe, increased temperatures will probably lead to lower annual evapotranspiration and lower organic matter accumulation in soil. The role of vast boreal wetlands as carbon sinks may thus be suppressed. In central and western Europe, the risk of floods may support the political will for ecosystem-unfriendly flood defence measures, which may threaten the hydrology of existing wetlands. Southern Europe will probably suffer most from water shortage, which may increase the competition for water resources between agriculture, industry and settlements on the one hand and nature conservancy, including wetland conservation, on the other.

References

Čížková H, Květ J, Comín FA, Laiho R, Pokorný J, Pithart D (2013) Aquat. Sci. 75, 3–26.
Junk WJ, An S, Finlayson CM, Gopal B, Květ J et al. (2013) Aquat. Sci. 75, 151–167.

Timing of phenological phases and their overlapping in flood-plain forest ecosystems

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There is a growing concern that the climate change has significant impacts on species phenology, seasonal population dynamics, and thus interaction (a)synchrony between species. Species that have historically undergone life history events on the same seasonal calendar may lose synchrony and therefore lose their ability to interact as they did in the past. In view of the match/mismatch hypothesis, the different extents or directions of the phenological shifts among interacting species may have significant implications for community structure and dynamics. That is the reason why our principal goal of the study is to determine the phenological responses within the ecosystems of flood plain forests and to analyze the phenological overlapping among each phenological period of the given species.

The phenological observations were made at flood-plain forest experimental sites in southern Moravia during the period 1961-2012. One whole ecosystem in this study creates 17 species (15 plants and 2 bird species) and each species is composed of 2 phenological phases. Phenological periods of all species of the ecosystem overlap each other, and 43 of those overlapping were chosen. The length, trend, and correlation with temperature were elaborated. The dynamic, changes, shifting and overlapping among phenological phases were also compared with the timing of phenological phases from two other ecosystems of flood-plain forests.

The analysis of the overlapping phenophases of the species chosen showed that the length of overlaps was getting significantly shorter in 1 case. On the other hand, the length of overlaps was getting significantly longer in 4 cases. The remaining overlaps (38) of all phenological periods among various species was either getting shorter or longer, but with no significance or alterations. The results also showed a robust and stable phenological response of species among all three flood-plain forest ecosystems studied.

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Environmental monitoring of the Russian spaceport «Vostochny»

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An environmental monitoring includes the monitoring of landscape elements, assessment, prediction and presentation of actual information about the environmental situation for management decisions, and the detection of irregularity states of environment. Particular attention is paid to control the environment in the field of high economic activity, for example, the territory under construction of the Russian spaceport «Vostochny». Remote sensing techniques allow us to examine ecosystem processes at multiple scales and provide a large area covering of the spaceport.

The spaceport «Vostochny» is located in the Amur Oblast, Russia. The study area includes the territory of the spaceport and its surrounding territory (total area 440 km2). The landscape is mostly covered with deciduous (mainly birch and oak), evergreen (mainly pine) or larch forest. Theoretical research included the rationale for the selection of satellite, airborne and ground based monitoring tools, elaboration of methodology and software development. Experimental researches included the satellite and airborne data acquisition, and ground measurements on the study area, data processing and complex environmental assessment. We used satellite time series Landsat-5/8 data of 2013-2014, satellite hyperspectral Resurs-P images obtained in 2013 and satellite multispectral Kanopus-V images obtained in 2014. Airborne data were acquired by the thermal scanner Malahit (8-14 mkm, 1.3 μrad angle of view, 0.1 K sensitivity), hyperspectral Fregat sensor (400-1000 nm, spectral range of 7 nm, spatial resolution of 2 m) and the digital camera Hasselblad H4D-50 (RGB, spatial resolution of 0.5 m) of 2013. The processing of these data was aimed at the detection of characteristics of main landscape components of the study area - forest cover, water bodies and soil cover.

A complex environmental assessment was based on the methodology of ecological zoning of the territory represented as a territory division to the degree of anthropogenic intensity (Ia) by means of a geographical informational system. Where Ia was a five-point evaluation of the ecosystem balance based on the degree of anthropogenic transformation and potential sustainability: good, satisfactory (destruction of sensitive species), tense (structural changes), crisis, and catastrophic (destruction of the ecosystem). For mapping Ia, the spaceport territory was covered with a grid of elements of 1x1 km where each element contained a description of the environmental conditions of vegetation, water areas, land cover obtained from the processing of satellite and airborne images. The degree of the anthropogenic load and the stability of the ecosystem were estimated as a weighted sum of the degree of pollution and negative impacts and are represented in every grid element.

Complex assessments of the spaceport ecosystems showed that there was an increase of negative environmental changes by natural and anthropogenic factors. The complex environmental assessment was characterized as satisfactory but close to a tense due to the active construction and expansion of the area of the anthropogenic load in 2013. In 2014 the environmental situation was characterized as tense. This is mainly due to the reduction of vegetation as a result of forest fires and deforestation, including illegal forest cuts, as well as the expansion of the area of open pits and the presence of contaminated soils (residues of waste oil and dumps).

References

Grigorieva O, Mochalov VF (2014) Ecology and Space, 31 (Russian).

Mapping aboveground forest biomass using airborne data

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Monitoring and measuring of forest aboveground biomass (AGB) has become an important research topic in recent years as for its significance in better quantifying stocks and fluxes within the global carbon cycle. Different remote sensing tools have shown a potential to derive some categories of forest attributes related to the AGB. Among these an airborne laser scanning (ALS) has been numerously reported as a suitable data source for estimation of AGB due to its ability to estimate forest structure properties. In contrast, imaging spectroscopy has been considered so far as a tool with low predictive value for biomass estimation when used alone. This study presents two methods for the estimation of forest AGB using hyperspectral and LiDAR data. The main objective of the study to examine either of the two methods can be used independently for AGB assessment in the study area as an alternative to traditional ground methods.

Two categories of airborne data and one set of field inventory data were used for spruce forests in Beskydy Mountains of the Czech Republic: 1/ airborne hyperspectral (AISA Eagle scanner, 0.4 m pixel size, 0.40 – 0.89 μm, 64 bands); 2/ ALS data (Riegl LMS-Q680i, near IR-wavelength, 50 point/m2); 3/ field measurements of tree height, diameter at breast height, age, species composition and other stand parameters using Field-Map technology for each forest plot (www.fieldmap.cz).

The first method estimated AGB for plot level from high spatial resolution hyperspectral data was based on the next steps: creation of the map of species composition using a supervised classification of airborne hyperspectral data, tree height values calculation for each forest plot, calculation the crown density values for each forest plot, calculation of biomass values from a Cluster Labelling Using Structure and Type (BioCLUST) model. Finally, we compared biomass from hyperspectral data with the biomass from field inventory data for plot level.

The second method estimated the biomass from airborne laser scanning data and used an individual tree crown approach. It was based on the next steps: transformation LiDAR point cloud into a canopy height model (CHM), detection of individual tree positions, calculation of AGB values using four different allometric equations for biomass estimation from height and/or diameter at breast height (DBH). Finally, we compared biomass estimates from LiDAR data with the biomass from field inventory for a tree level.

The results showed: 1/ AGB from hyperspectral data had a good correlation with the forest inventory biomass values (R2 = 0.64); 2/ AGB from LiDAR data was correlated strongly with the forest inventory biomass values using four different allometric equations (R2 = 0.76 to 0.79); 3/ a high agreement was achieved between tree heights estimated from laser scanning data and field measurements (R2 = 0.99). Study results indicated either of the two methods could be used independently for AGB assessment in the study area as an alternative to time-consuming and commonly resource-demanding traditional ground methods.

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The effects of applying deicing salts to ecosystems in protected areas

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The negative effects of applying deicing salts to ecosystems are well documented for many countries. In some countries including the Czech Republic, the application of the deicing salts to roads in protected areas is prohibited by law. Conditions of applying of deicing salt are defined by the statutory exemptions for the several main roads in the Šumava National Park and the Šumava Protected Landscape Area. Chemicals can be used only on the main roads and several others can be chemically cleaned only in extremely hard climatic conditions (i.e. slippery ice, rain, frost). Detail monitoring of the effects of deicing salts on ecosystems has been started ten years ago. Ten permanent study sites were established and soil conditions, chemical parameters and vegetation (phytoindication) have been studied annually. Following chemical parameters were measured: pH, conductivity, Na^+, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, K^+. The species occurrences and their salt-tolerance were recorded in transects along the road edge and in distance 1 m. Significant differences in soil chemical parameters among the different sites were recorded and also trends in growing concentrations of Cl^- ions were found. Proportion of halophytes increased in several sites too. More results and trends are going to be discussed.

There is a big question: How we can explain growing negative effect of salting on sensitive ecosystems in time of global warming when winters are getting more and more moderate?

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The dependence of the soil CO2 flux on the selected root parameters of Norway spruce and sterol content in the soil

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The soil CO2 efflux is an important part of the carbon cycle in temperate forests, where it makes up 60-80%, escaping from the entire ecosystem to the air (Le Dantec et al., 1999). The CO2 flux from the soil thus significantly contributes to the reduction of the amount of carbon captured by a forest. Roots in their surroundings create a specific environment inhabited by numerous species of microorganisms. Therefore, it is important to know the role of the roots and rhizospheric microorganisms (above all ectomycorrhizal fungi) in the release of CO2 from the soil. Sterols are one of the most important substances in the soil, which indicate the presence and physiological activity of plants (phytosterols), animals (e.g. cholesterol) and fungi (e.g. ergosterol). Ergosterol is a common biomarker for fungi and its occurrence suggests recent metabolically active fungal biomass and therefore its quantification in the roots and soils is often used for indirect measurement of mycorrhizal systems (Nylund and Wallander 1992). The concentration of β-sitosterol, as a major plant sterol, in soil can be related to the cultivation type and presence of decomposing plant matter and could be considered as an indicator of the phytomass quantity in the soil (Pulgisi et al. 2003). The aim of our paper is to help to clarify the dependence of soil CO2 flux on the selected parameters of the root system and rhizosphere microflora. The research on the effects of root biomass and ergosterol and phytosterol content in roots and soil on the CO2 efflux from the soil has been carried out in the 108-year-old Norway spruce (Picea abies) forest in the Rajec nad Svitavou-Němčice in Drahanská vrchovina (highlands) in 2010 and 2011. The CO2 efflux was measured using the gazometric system LI 8100 (Li-Cor, USA). Before the measurements the humus layers were separated from the mineral layers by inserting a sharp metal sheet. All the soil with roots, located in the circle measurement chamber over the metal sheet, was sampled and analyzed. The dry weight of individual root categories (<1 mm, 1-2 mm, 2-5 mm, >5 mm), ergosterol, ergosterol/β-sitosterol ratio, cycloartenol/ ergosterol ratio, cycloartenol/ β-sitosterol ratio were determined. Our results of soil respiration correspond with findings of Buchman (2000) who ascertained values of respiration between 5 and 7 μmol CO2 m–2 s–1. in a 111-year-old spruce forest. A significant influence on soil respiration was proved only for the sitosterol content in the soil. This corresponds to the observation of Kanerva et al. (2007). The relationships between soil CO2 flux, soil properties, root characteristics and sterol content in roots and soil will be discussed.

References

Buchmann N (2000) Soil Biol. Biochem. 32, 1625–1635.
Le Dantec V,Epron D, Dufrene E (1999) Plant Soil 214, 125–132.
Kanerva S, Kitunen V, Loponen J, Smolander A (2007) Biol. Fert. Soil 44, 547–556.
Nylund J-E, Wallander H (1992) In: Norris JR, Read DJ, Varma AK (eds), Methods in Microbiology, vol. 24. London: Academic Press, 77–88.
Puglisi E, Nicelli M, Capri E, Trevisan M, Del Re AAm (2003) J. Env. Qual. 32, 466–471.

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Are there any changes in the Czech Republic regarding the start of the flowering season of important allergens?

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Phenological observations have a long tradition in the Czech Republic, the first phenological notes were already carried out in the 18th century. At the phenological observation network of the Czech Hydrometeorological Institute, as a whole, 45 plant species are observed, they are perennial herbs, grass or ground bushes growing in the wild. Some of the observed species belong to the group of so-called allergens, e.g. birch (Betula pendula), cocksfoot (Dactylis glomerata) and meadow foxtail (Alopecurus pratensis). In this paper we evaluated the phenological phase of above mentioned plants during the start of flowering at the research plot Mlýny, Chřibská (50° 52' N, 14° 29' E, 350 m asl). We used the meteorological data of the Varnsdorf meteorological station (48°56‘ N, 16°35‘ E, 367 m a.s.l.). The aim of this work was to assess the meteorological parameters that influence the phenological onset, to analyze the date shifts of the phenophase onset during 1959–2014, and the temperature trends during this period. The meteorological and phenological data were processed via the PhenoClim software (for calculating temperature thresholds Tbase and the sums of the effective units Ts) and Excel. The average date of the flowering start during the time period 1959–2014 is April 28, with a standard deviation of 10 days (Betula pendula), May 20 with a standard deviation of 8 days (Alopecurus pratensis) and June 7 with astandard deviation of 13 days (Dactylis glomerata). Dactylis glomerata shows the largest deviation (positive and negative) from the long-term average (1959–2014): +29 days in the year 1980 and -29 days in the year 1995. The species studied are allergens and their timing and phenological shifting during spring as well as their relationships with climate parameters supply us with important information for planning as well as issuing warnings.

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Spring drought effect on above-ground biomass development and CO2 efflux in the grassland ecosystem

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Ecosystem respiration is an important component of the carbon cycle. The response of respiration to the climate change can have a significant effect on carbon sequestration in the terrestrial ecosystems in the future when, according to different climate scenarios, spring drought and consequent heavy summer rains are expected.

In our study we measured the ecosystem CO2 efflux from the grassland on plots with ambient precipitation conditions (AMB) and on plots where a manipulative drought (DRY) was induced in the first half of the growing seasons 2011-2014. The dry and ambient precipitation conditions were enabled by roofs with a different arrangement of plates. In the summer after the drought period, single watering of the DRY variant was performed to simulate 30mm rainfall.

The spring drought significantly decreased the amount of above-ground biomass in all years except for 2014. The difference in the amount of above-ground biomass between AMB and DRY variants was influenced by the amount of precipitation and by the beginning of the growing season.

The drought had a fast significant effect on the ecosystem's CO2 efflux. It was lower by up to 45% in DRY compared to AMB. Roof removal resulted in a gradual increase of CO2 efflux in DRY to reach the rates of AMB and after watering of DRY, CO2 efflux in this treatment was temporarily higher than in AMB.

According to our results we can assume that the future spring drought would have a significant effect on the carbon balance of grassland ecosystems. The strength of the impact will depend on the length of the dry period and also on the time between the beginning of the growing season and the dry period, when the plants can grow and sufficiently establish their root system.

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Long term productivity of short rotation coppice under decreased soil water availability

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"Wood, in fact, is the unsung hero of the technological revolution that has brought us from a stone and bone culture to our present age." Perlin and Journey (1991). Given its high-energy content and versatile use, biomass in the form of wood has been used for energy purposes for millennia and has been the preferred source of biomass over the years. Ever since, the production and use of woody biomass resources expand globally. The main drivers for this use as a source of energy are diversification and the mitigation of energy related greenhouse gas (GHG) emissions through a partial substitution of fossil fuels. An alternative option for wood biomass sources originating from natural forests is short rotation woody coppice. Its productivity is largely dependent on the environment in terms of climatic conditions. Particularly drought is the major constraint of woody biomass production involving serious economic consequences. In Central Europe, increased global radiation and air temperature together with decreased relative humidity increase the reference evapotranspiration resulting in an increased demand for soil water during the growing season. For that reason, our field experiment was designed to evaluate the impact of decreased soil water availability on the productivity of poplar based short rotation coppice plantations during multiple growing seasons. A throughfall exclusion system based on plastic roof strips placed under the canopy was used to drain up to 70% of the incoming rain water. The usual methods were applied to assess the annual aboveground biomass increments expressed in dry matter content. Not surprisingly, our results show a systematic decline in the productivity of plots subjected to decreased soil water availability but also considerable resilience of the drought-stressed trees which will be also discussed.

Acknowledgement

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The effect of drought and nitrogen fertilization on the production, morphometry and spectral characteristics of winter wheat

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Methods of study based on the spectral reflectance of vegetation are now commonly used in research of both natural ecosystems and field crops (e.g. Aparicio et al., 2000). The aim of this experiment was to evaluate the effect of drought and nitrogen (N) fertilization on the N use efficiency in wheat and to apply the obtained spectral characteristics to assess the heterogeneity of stands as a potential consequence of different nutrition of the crops. Consequently, the main goal of the study is to identify vulnerable areas in terms of danger due to a high level of nitrates in underground water.

Twelve experimental plots of winter wheat were manipulated to drought from 8.5.2013 to 12.6.2013. The effect of the drought was observed in the variants: control without fertilization (0 kg N/ha) and N fertilization (100 kg N/ha). Subsequently, plant samples were taken for the determination of aboveground biomass and N and carbon contents in dry matter. The spectral characteristics of wheat were measured in the earing phase at both leaf (SpectraPen) and plot (Field-Spec) levels.

The effect of droughts on morphometric parameters of winter wheat was statistically significant only in N fertilization (N100). The total aboveground biomass significantly decreased by 18% in the N100 variant as a result of the simulated drought. This decrease was reflected in a statistically significant reduction of all individual plant parts (stems, leaves, spikes) in the variant N100. The response to drought stress was observed in many vegetation indices, particularly in NDVI, GNDVI or WI/NDVI. The results show that there are significant relationships between N content in the grain and many vegetation indices. Particularly, we found quite a marked separation of the relationships between the dry and wet variants for the vegetation indices NRERI, TCARI/OSAVI, VOG2 and GM. Generally, the impact of droughts increased at higher levels of N content in the grain which corresponded with the results of the morphometric analysis.

The use of reflectance in the study of vegetation and field crops regarding risk assessment of the mineral N leaching from soils, provides considerable potential, especially in the mapping of large areas and capturing of temporal changes related to N release.

References

Aparicio N et al. (2000) Crop Sci. 42, 1547–1555.

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Continual reflectance measurements at experimental forest sites

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Continual reflectance measurements at experimental forest sites are being conducted to validate relationships of optical indicators to measure estimated forest stand photosynthesis using the eddy-covariance technique. Brief analyses of collected data revealed well known attributes of traditional approaches for estimating light use efficiency (LUE). The Photochemical Reflectance Index (PRI) precluded the application for rapid estimating of LUE. The indicative ability of PRI can be confused with physiological processes running at a thylakoid level. PRIs collected during different periods of the day are incomparable as the PRI of forest stands with a complex structure is sensitive to the sun's azimuth and elevation angle. Better overall results have been achieved after applying integral algorithms in the blue-green region of reflectance signatures. Parameter integrating information in several wavebands does not exhibit angular sensitivity and showed a better overall performance in estimating LUE during midday. Our research group also turned their attention to analyses of fluorescence signal responses; in this particular case the study is aimed at investigating responses of passive fluorescence to photosynthesis dynamics in forest stands. The red and far red fluorescence ratios did not exhibit any sensitivity to LUE. On the other hand, fluorescence retrieved with the infilling O2A band (759 nm) exhibited the closest relationship to LUE. The O2A band falls into region of the dominant photosystem I emission with a substantial photosystem II fluorescence contribution. The corresponding fluorescence peak (centred at 740 nm) is quite reactive to environmental factors as compared to the photosystem II peak centred at 690 nm. Spectra are measured in nanometre resolution, the resolution is sufficient for fluorescence retrieval using the Fraunhofer line infilling methods. In the upcoming years, data collected with continual instruments should serve as purposes for COST Action OPTIMISE, where the construction of a data sharing portal is planned for purposes of data distribution and processing. A substantial part of this project is also dedicated to studies of vegetation fluorescence. Continual measurements at sites equipped with the eddy-covariance system is essential for the engagement in Specnet network, where spectral data, together with flux and meteorological data, serve as a purpose for the validation of MODIS data products across different biomes worldwide. This project aims at the attention of the PRI and NDVI principles.

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The influence of air elevated [CO2] and admixture on the basic dendrometric parameters of young beech and spruce trees

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Due to more frequent occurrence of weather extremes, forest stability can be preferentially required. Recently, the transformation of the Norway spruce (Picea abies (L.) Karst.) monoculture to mixed stands has started. As an appropriate tree species to stabilize and ameliorate Norway spruce forest stands the European beech (Fagus sylvatica L.) was widely used. The question is: what is or what can be the best admixture of this tree species in the future environment?

The study presented here took place at the Experimental Research Site (ERS) Bílý Kříž in the Beskydy Mts. (908 m a.s.l., 49°30'09'' N; 18°21'19'' E). Spruce and beech trees were cultivated inside two glass domes (GD) with adjustable windows. The air with ambient (A; 385 μmol(CO2) mol-1) and elevated [CO2] (E; 700 μmol (CO2) mol-1) was distributed within the GD by a system of radial and auxiliary fans. A more detailed description of the GD infrastructure can be found in Urban et al. (2001). All measurements were carried out on young beech and spruce trees, which were planted as three-year old seedlings in autumn 2005. Three admixture types were arranged – a single tree mixture, a group trees mixture and a pure one (monocultures for both investigated tree species).

After eight years of the trees' cultivation in GD (i.e. in August – September 2013), all the trees were harvested. The total tree height and stem diameter at breast height (DBH) of spruce and beech trees were measured.

Beech did not show a significant difference in DBH or total tree height. Only spruce trees grown in an admixture arrangement significantly differed from others in DBH.

References

Urban O et al. (2001) Photosynthetica, 39, 395–401.

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The effect of induced drought on Norway spruce tree and stand transpiration

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In changing climate, frequent occurrences of extreme weather conditions, such as drought periods is presumed. This may negatively affect forest growth and stability. Norway spruce, one of the most important tree species in Europe, seems to be quite vulnerable to drought stress, due to its shallow root system and planting outside of its ecological optimum. Therefore, this study aimed to analyse the effect of limited water availability by canopy throughfall reduction on Norway spruce tree and stand transpiration. The study took place in two young pure Norway spruce stands located in the uplands of the east part of Bohemia, Czech Republic, from July through October 2014. In one of these stands - PF, precipitation throughfall was reduced by ca. 30% by installing a plastic foil coverage between the tree rows. The PK stand was the control plot. Trees were divided into three tree-size classes: suppressed, co-dominant and dominant on the basis of the diameter at breast height (DBH) distribution. Tree and stand transpiration were derived from sap flow measurement by the tissue heat balance method (THB). Ten sample trees per plot were selected to conduct the measurement. Transpiration was evaluated in relation to the stand structure and microclimatic conditions.

The mean daily tree sap flow differed among studied stands and tree sizes and it increased with increasing DBH. On average the dominant trees transpired eight to ten times more than suppressed ones. Surprisingly, the dominant trees in the stand with reduced soil moisture transpired more than in the control stand. The effect of induced drought was more visible on the co-dominant trees. The tree size class contribution to the stand transpiration varied between PF and PK. The co-dominant trees had the biggest contribution in the PK transpiration, whereas the co-dominant and the dominant trees contributed almost equally to the PK stand transpiration. The PF stand transpired significantly less than the PK during the warmer part of the measurement period with the mean VPD above 100 Pa. The drought affects water distribution in tree size classes, which should be taken into account when planning silvicultural treatments in order to equilibrate or enhance a stand's water balance. Therefore, the highest reduction of transpiration in stands under frequent water stress can be caused by cutting the dominant trees (e.g. crown thinning).

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Assessment of leaf area index development and radiation use efficiency of a high-density coppice culture of the poplar clone J-105

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The leaf area index (LAI) is one of the most frequently used parameters for the analysis of canopy structure and crop productivity. Our study was based on the hybrid poplar clone J-105 (Populus nigra x P. maximowiczii) grown in a high-density (9216 trees ha-1) short-rotation coppice culture. The coppice culture was established in April 2001 on former agricultural land in the Bohemian-Moravian Highlands (49°32'N, 16°15'E, 530 m a.s.l.). The aim of this study was to assess the LAI and the radiation use efficiency (RUE) of the poplar clone J-105 before and after the first coppice. We analyzed the first (2001-2009, non-coppiced) and second rotation (2010-2012, coppiced) for this study. The LAI was measured indirectly with the SunScan Plant Canopy Analyzer, and the maximum seasonal LAI was validated against the directly measured maximum LAI (i.e. litter collection). The RUE was estimated as the ratio between the total above-ground woody biomass and the available photosynthetic active radiation (PAR) accumulated in one growing season. In the non-coppice rotation, the LAI reached a maximum of 7.3 (2009), whereas the maximum LAI in the coppice rotation reached 6.8 (2012). The maximum RUE reached in the non-coppice rotation was 0.25 g mol-1 (2009), whereas in the coppice rotation it was 0.20 g mol-1 (2012).

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Comparison of emissions of biogenic volatile organic compounds from leaves of three tree species

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Biogenic volatile organic compounds (BVOC) play many roles in the ecophysiology of plants and have the potential to affect the atmospheric quality due to their chemical reactivity. Rates of BVOC emissions depend on plant species, growing condition and have diurnal and seasonal patterns. Our study evaluates the classes of BVOCs emitted from different tree species and if the BVOC emission correlates with the rate of the CO2 assimilation.

We have investigated the BVOC emissions of two tree species grown in the field (Norway spruce, sessile oak) and from 1-year old cuttings of hybrid poplar (J-105) grown in laboratory conditions. Emitted BVOCs were sampled on Tenax tubes (Markes Unity System 2, Markes International Ltd., UK) in parallel with the gas-exchange measurement of the CO2 assimilation rate and the stomatal conductance by LI-6400 (LiCor, USA). After subsequent thermal desorption of the Tenax tubes, the profile of the BVOC was estimated by gas chromatography coupled with mass spectrometry (GC-MS, Agilent, USA).

Tree species showed marked differences in total emissions of BVOC ranging from 2.33 to 25.67 nmol m-2 s-1. Spruce trees had the lowest BVOC emissions and the lowest CO2 assimilation rate as well as stomatal conductance per unit leaf area. Oak had slightly higher BVOC emissions than poplar. Isoprene comprised more than 97% of the total BVOC emissions from oak and poplar, whereas isoprene emissions from spruce needles were negligible. Spruce BVOC emissions were composed mainly of monoterpenes. The main monoterpenes were limonene, α-pinene and β-pinene. No clear correlation between BVOC emissions and the CO2 assimilation rate was found, although a certain interdependence of these processes is likely.

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Early detection of Plasmopara viticola infection in grapevine leaves using chlorophyll fluorescence imaging and the relating production of stilbenes - field study.

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Climate changes influence the habitat range of pathogens, with increasing temperature facilitating pathogen spread (Madgwick et al., 2011). Plasmopara viticola is one of the most significant diseases endangering the grapevine production. Chlorophyll fluorescence (Chl-F) distribution over naturally infected leaves was used for an early detection of P. viticola infection in the field on sensitive and resistant varieties. In parallel, the content of two major phytoalexins (trans-resveratrol and pterostilbene) as well as the newly identified 2,4,6-trihydroxyphenanthrene-2-O-glucoside (Tříska et al., 2012) were analyzed. The maximum and effective quantum yield of photosystem II efficiency (F_V/F_M, Φ_{II}) were selected as the most potent fluorescence parameters (Cséfalvay et al., 2009). All infected leaves expressed a heterogeneity in F_V/F_M, Φ_{II} distribution revealing the early stage of P. viticola infection before the infection significantly affected the whole leaf performance. FV/FM declined at the same level in sensitive and resistant varieties but the distribution over the leaves differed. Concentrations of the tracked stilbenes were significantly higher in infected leaf spots expressing lower FV/FM, but no clear difference in stilbene production was observed between the groups of susceptible and resistant varieties. Stilbene production correlated well with the decrease of FV/FM in infected leaf tissue. 2,4,6-trihydroxyphenanthrene-2-O-glucoside production was higher in grapevine varieties producing trans-resveratrol to a higher extent. Since 2,4,6-trihydroxyphenanthrene-2-O-glucoside emits a high UV fluorescence signal, we propose that a combination of Chl-F and UV induced fluorescence of stilbenes offers a unique opportunity to develop a non-invasive method for large-scale screening of quantitative resistance to P. viticola.

References

Cséfalvay L et al. (2009) European Journal of Plant Pathology 125, 291-302.
Madgwick JW et al. (2011) European Journal of Plant Pathology 130,117-131.
Tříska J et al. (2012) Molecules 17, 2773 – 2783.

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CN-PAGE as a tool for separation of Pigment-Protein Complexes and study of their thermal stability in spruce and barley thylakoid membranes

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The crucial aim of our study was to develop a method for the solubilization and the following native electrophoretic (colorless-native polyacrylamide gel electrophoresis; CN-PAGE) separation of pigment-protein complexes (PPCs) embedded in thylakoid membranes (tBMs), which have been isolated from spruce plants. Afterwards, we focused on the study of temperature effects on composition and PPCs stability in two different species – spring barley (Hordeum vulgare L. var. Bonus) and spruce [Picea abies (L.) Karst.] plants.

The effective, but gentle solubilization of PPCs from tBMs (comprising a disruption of protein-lipid and maintaining of protein-protein interactions) is essential for the separation of PPCs in their native state by CN-PAGE. Due to the fibrous character of the needles and the presence of waxes, tannins and phenols, the spruce thylakoid isolation is bit different from that of barley and the usage of young spruce seedlings (ca. 16-26 days after seed sowing) seems to be more appropriate for tBM isolation in contrast to mature needles. Moreover, suspensions of tBMs isolated from spruce seedlings repeatedly contain sufficient amounts of total chlorophyll (1000 μg chlorophyll a+b/ml) for CN-PAGE demand in contrast to older needles. Isolated tBMs were solubilized by mild detergent dodecyl -D-maltoside (DM) with detergent to total chlorophyll ratio 20:1 (barley) and 35:1 (spruce). CN-PAGE using a focusing gel (4% acrylamide concentration) and a separation gel with a gradient of acrylamide concentration (4.5-11.5 %) resulted in the separation of photosystem I (PSI) and photosystem II (PSII) supercomplexes (SCs), PSI-PSII dimer, PSII monomer, trimeric and monomeric light-harvesting complexes of PSII (LHCII) and a band with free pigments.

The effect of elevated temperatures on PPC composition was realized by exposure of tBMs to a water bath preheated to 20, 32, 36, 40 and 55°C in a dark room. This experiment revealed different thermal stabilities of PPCs in spruce and barley tBMs. Almost no changes in the PPC content and composition occur within the temperature range of 20-36 °C. Pronounced PPCs changes were observed at temperature equal to or higher than 40°C. We revealed a partial disappearance of PSI and PSII SCs at 40°C in barley, whereas in spruce it toop place at 55°C. The disappearance of SCs at 55°C was accompanied with the formation of PPC aggregates (observed as insolubilized PPCs in wells of CN-PAGE gel), an increase of LHCII in monomeric form and intensity of a free pigment band in both plant species but more pronouncedly for barley plants. These changes probably suggest a better thermal stability of tBM of spruce vs. barley plants, which is also confirmed by measurements of CD spectra of isolated tBMs at different temperatures.

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The thermostability of photosystem II photochemistry is related to the maintenance of the thylakoid membranes organization

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The response of higher plant photosynthetic reactions to temperature changes are of crucial importance if we take into account both the global warming and the increasing frequency of extreme temperature fluctuations. An elevated temperature can cause direct negative effects on the photosynthetic assimilation of carbon dioxide and the photosystem II (PSII) component oxygen evolving complex (Lípová et al., 2010; Zhang & Sharkey, 2009) is considered the most heat sensitive. In our previous work (Špunda et al., unpublished results) we have shown several features of the Norway spruce photosynthetic apparatus that have not been observed in control plants, such as Arabidopsis or barley. They are mainly rapid acceleration of violaxanthin deepoxidation by short pulses of saturating light at higher temperatures or higher thermostability of PSII photochemistry for spruce compared to control plants. In this work we have focused on the study of macro-organisation of pigment-protein complexes (PPCs) in thylakoid membranes of the plant species mentioned.

We have found that the maximum efficiency of PS II photochemistry (FV/FM) of control plant leaves strongly decreased at 42 °C and almost the complete PS II inactivation occurred at 46 °C. In contrast, PS II inactivation was more gradual in spruce needles at temperatures above 40 °C and FV/FM values higher than 0.5 at 46 °C were observed. For the estimation of chiral macro-organisation of PPC in the thylakoid membrane (Garab & van Amerongen, 2009) we have used circular dichroism (CD) spectroscopy as a non-invasive method for the investigation of pigment-pigment interaction, even in a system as highly complex as an intact cell in vivo. Temperature-dependent CD spectra have demonstrated a higher PSII thermostability of spruce thylakoid membranes (about 5 °C) in comparison to control plants assessed on the basis of the transition temperature defined as the temperature at which the intensity of the CD band is decreased to 50 % of itsvalue at 25 °C(Krumova et al., 2010).

These results indicate that the stability of PSII macro-organisation in different plant species quantitatively correlates with the thermal stability of PSII photochemistry in intact needles/leaves and is therefore related to the maintenance of photochemical activity under high temperature stress.

References

Garab G, Van Amerongen H (2009) Photosynth. Res. 101, 135–146.
Krumova SB et al. (2010) Photosynth. Res. 105, 229–242.
Lípová L et al. (2010) Biochim. Biophys. Acta-Bioenerg. 1797, 63–70.
Zhang R, Sharkey TD (2009) Photosynth. Res. 100, 29–43.

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This work was supported by the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPU I), grant number LO1415, Global Change Research Centre ASCR, v.v.i. No. CZ.1.05/1.1.00/02.0073 and Grant Agency of the Czech Republic No. 13-28093S/P501.

Cultivation of photoautotrophic plant suspension cultures in photobioreactors.

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The aim of our study is to find optimal conditions for cultivation of photoautotrophic (PA) plant cell cultures in photobioreactors originally designed for microalgae. Plant suspension cultures represent a reduced model of a complex and heterogeneous system of higher plants. They are used in biotechnology for the production of highly valuable secondary metabolites (Berkov et al., 2014; Fischer et al., 1994). They consist of single cells or small clusters forming uniform populations directly accessible to exogenous stimuli, which makes them ideal for experimental use (Roitsch, 2002). Plant suspension cultures thus pose a significant and promising experimental and biotechnological system. However, they need CO2 as a carbon source for their growth, which makes the cultivation of PA cultures somewhat complicated.

Photobioreactors provide variable settings of light composition and intensity, temperature, and additional stirring; online monitoring of multiple cultivation parameters; sterile cultivation conditions; a CO2 enriched atmosphere (Nedbal et al., 2008; Červený et al., 2009). In addition, compared to the regular cultivation setup in two-tiered flasks, photobioreactors enable upscaling of the culture's working volume (from regular 70 mL up to 400 mL) providing A) enough homogenous material for consequent experiments, B) an intermediate step in advanced upscaling for biotechnological applications.

In our experiments, we compare three different cultivation setups: 1) a regular setup in two-tiered flasks with separated CO2 buffer at the bottom part, 2) a novel setup in Erlenmeyer flasks in a special cultivation chamber (AlgaeTron AG 230, Photon Systems Instruments, Czech Republic) with a CO2 enriched atmosphere, 3) a novel setup in photobioreactors with CO2 enriched air supply. Various growth characteristics including chlorophyll and biomass production were measured throughout the three-week time course of the experiments. The data presented are for PA cell cultures of Chenopodium rubrum.

Our results show that the cultivation in a much simpler setup of Erlenmeyer flasks is comparable to the traditional, more laborious cultivation in two-tiered flasks. Regarding the cultivation in photobioreactors, results indicate the possibility of the cultivation of PA cell cultures in photobioreactors originally constructed for the cultivation of microalgae, however several species-specific issues connected to upscaling have yet to be resolved.

References

Berkov S et al. (2014) Engineering in Life Sciences 14, 643–650.
Fischer U et al. (1994) Plant Cell, Tissue and Organ Cult. 38, 123–134.
Roitsch T, Sinha A (2002) Photosynthetica 40, 481–492.
Nedbal L et al. (2008) Biotech. and Bioeng. 100, 902–910.
Červený J et al. (2009) Engineering in Life Sciences 9, 247–253.

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Development of high-lipid content strains of microalgae Chlamydomonas reinhardtii by fluorescence-activated cell sorting.

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Green microalgae are among the most widely distributed microorganisms in the biosphere. They are significant contributors to global photosynthetic productivity and they are interesting to biotechnology due to their large variety of high value compounds accumulation and range of applications. The production of profitable microalgae cultures for biotechnology should combine two usually antagonistic properties: a fast growth and a high accumulation of specific target compounds (Li et al., 2008).

Here, we focus on the development of advanced cultivation strategies (Zavřel et al., 2015) and breeding methods applied on a model organism, unicellular microalgae Chlamydomonas reinhardtii, for optimized production of lipids.

For identification, isolation and subsequent selection of the optimal subpopulation with high lipid content we used high-throughput fluorescence-activated cell sorting (FACS) in combination with imaging flow cytometry on the cells stained with lipid-specific fluorescent dye (Hyka et al., 2013) BODIPY. We observed that post-sorting cell viability is not negatively influenced by external parameters used during the sorting procedure (pressure, light quality and quantity, influence of the electro-magnetic sorting field, toxic effects of both fluorescent marker and fluidic system medium composition).

An additional outcome of the methods developed and the cultivation strategies will be a set of genes that contributes to increased lipid accumulation and can be used as a clue for enhanced artificial genetic manipulation.

References

Hyka P et al. (2013) Biotechnol. Adv. 31, 2–16.
Li Y et al. (2008) Biotechnol. Progress 24, 815–20.
Zavřel T et al. (2015) Eng. Life Sci. 15, 122–132.

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Transcriptomic and genomic evidence for a metabolic rhythm in Cyanothece sp. ATCC 51142

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Červený et al. (2013) have reported the identification of a temperature-dependent ultradian metabolic rhythm in the diazotrophic unicellular cyanobacterium Cyanothece ATCC 51142. This is the first evidence regarding an ultradian metabolic rhythm in cyanobacteria. We would like to support this finding by molecular biology techniques.

Here, we use gene expression analysis and imaging flow cytometry to study this rhythm. Quantitative real-time polymerase chain reaction (qPCR) is widely used for the determination of expression patterns under different environmental conditions. The method is strongly dependent on the identification of correct constitutive genes that are required for the maintenance of basic cellular function as so called housekeeping genes. To establish an exact expression level we use two housekeeping genes in our experiments, identified and successfully verified to function as housekeeping genes in our previous work. We also qualified DNA topology changes during the course of both entraining and free-running parts of the experiment by staining the cells with DNA-binding dyes (DAPI, Hoechst, Sybr Green) using high-throughput flow cytometry. The fluorescence methods used to study cell cycles in the marine cyanobacteria were cycles of fluorescence associated with DNA replication and cell division (Jacquet et al., 2001).

We report a transcriptional activity of kai genes, nif genes and DNA topology corresponding with ultradian modulation.

References

Červený J et al. (2013) Proc. Natl. Acad. Sci. U. S. A. 2013, 110, 13210–5.
Jacquet S et al. (2001) Appl. Environ. Microbiol. 2001, 67, 782–790..

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Analysis of the poplar water use efficiency at the Experimental site Domanínek

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The water availability of the locality constitutes one of the main constraint for short rotation coppices grown on arable land. As a convenient characteristic assessing how the water use is coupled with the biomass yields, so called water use efficiency (WUE) is proposed. One method of water use efficiency determination is presented within this study. The study was carried out at short rotation poplar coppice (poplar clone J-105) at the Test Station Domanínek, Ltd. at Bohemian-Moravian Highlands during the growing season 2013. Diameters at breast height (DBH) were measured for 16 sample trees where sap flow measuring systems (Granier's Thermal Dissipation Probe, TDP) were installed. TDP outputs are expressed as temperature differences (ΔT) between the heated and non-heated probes. Estimation of sap flux density (Fd) by the Granier method relies on the measurement of temperature difference (ΔT). Determination of maximum temperature difference (ΔTmax) is fundamental for sap flux density (Fd) calculation. Although ΔTmax can be theoretically defined as ΔT at Fd=0, many factors may prevent the occurrence of the zero flow state, such as night-time water movement for new growth (vegetative or reproductive) or water loss from the canopy due to high vapour pressure deficit (VPD). Therefore, the VPD condition was established for determination of ΔTmax. VPD condition was established as follows: VPD reaching values 0.2 at least 6 hours during night (from 21 p. m. to 3 a. m. and when the condition was fulfilled, the value at 3 a. m. was taken) because it is a supposed time after that the tree has no transpiration. The programmable part of Mini 32 software (www.emsbrno.cz) was used for application of the script establishing ΔTmax values under this VPD condition. Nevertheless, another script was applied on ΔT data set to determination of ΔTmax values for every night at 3 a. m. (as this is when ΔT should be at its daily maximum) without VPD condition restriction for comparison of both approaches. Since application of the two mentioned scripts led to two sets of resulting values, calculations of Fd and consequent sap flow values were computed for both variants of ΔTmax values. The sample trees were divided into 3 diameter classes according to DBH values at the beginning of regular measurements (April 24, 2013). Allometry was carried out on February 20, 2014 to calculation of aboveground woody biomass. The input data for calculations of WUE of aboveground woody biomass productivity was biomass increments and monthly totals of sap flow for 16 sample trees. The total WUE for 16 measured trees reached 4.93 g kg-1 (when calculated with data set without VPD condition) and 4.63 g kg-1 (when calculated with data set under VPD condition).

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Interactive effects of UV radiation and drought on the accumulation of flavonols and morphological parameters in selected herbs and grasses of the mountain grassland ecosystem

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The main objective of the four-year experiment conducted on a mountain grassland ecosystem was to investigate the interactive effects of UV treatment and drought on changes in the accumulation of UV-screening compounds (flavonols) and biomass in selected herbs (Hypericum maculatum, Rumex obtusifolius) and grasses (Agrostis tenuis, Holcus mollis).

Since drought and UV-B radiation induce similar protective mechanisms, we tested the hypothesis that the UV-B radiation moderates the negative effects of drought biomass production.

The experimental plots were manipulated using rain-out shelters enabling exclusion/transmission of incident precipitation and UV radiation. Generally, UV and drought treatments had a similar effect on the accumulation of flavonols. Within Rumex and Holcus UV exclusion resulted in a substantial reduction of UV-screening compounds, particularly under the conditions of ambient precipitation, whereas within Hypericum and Agrostis UV exclusion caused only a slight reduction of the flavonol content. Likewise, drought treatment caused an increase in the accumulation of flavonols per area unit. UV radiation slightly reduced the negative impact of drought on the total aboveground biomass, however, this effect varied between species and partly also between years. Within herbs UV radiation alleviated the effect of drought on plant biomass, whereas it was enhanced in grasses.

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Regulatory mechanisms of photosynthesis and iWUE in wheat genotypes with different ploidy levels during the drought stress

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This experiment was devised for the investigation of evolutionary causes forming mesophyll conductance changes for CO2 and resistance characteristics against drought for photosynthetic necessities. Therefore, the experiments were performed on genetically divergent Triticum species with different ploidy levels.

We realized laboratory experiments with controlled dehydration and subsequent rehydration. Non-invasive techniques were used to evaluate the effects of water stress on photosynthesis in four wheat genotypes of three species selected for contrasting water stress responses. The materials examined were the diploid species Triticum monococcum subsp. monococcum, tetraploid specie Triticum turgidum L. subsp. dicoccum (Schrank) Schuebl and hexaploid genotypes Triticum aestivum L. subsp. aestivum cv. Astella and Triticum aestivum L. subsp. aestivum cv. Biscay. The gas exchange measurements were made every day for the experiment duration between flag leaves and ambient conditions with simultaneously determined water relations. We measured the relation between photosynthetic assimilation for CO2 (ACO2) and the concentration of CO2 in the intercellular air spaces (Ci), i.e. A/Ci curves, which were then evaluated for the assessment of dehydration influence on photosynthetic processes. With graduated drought there was a decline of relative water content (RWC) in all examined wheat genotypes. We observed differences and a decrease of the photosynthetic assimilation rate (ACO2), stomatal (gs) and mesophyll conductance (gm), and the concentration of CO2 in the chloroplasts (Cc).

We also found differences in the regulation of iWUE in the wheat genotypes studied. It was observed that in T. monococcum influence of gm was suppressed and there was a dominating influence of gs on iWUE regulation. On the other hand, in hexaploid wheat genotypes we observed a prevailing influence of the gm role over the gs during water stress (gm/ gs>1) in photosynthetic regulations, but not iWUE.

Enhanced stomatal regulation in old wheat genotypes contributes to the improvement of iWUE in mild stress conditions. The particularity of the hexaploid species is their improved mesophyll conductance for CO2 and less reactive stomata, leading to a higher maintenance of the photosynthesis rate in a mild stress condition, but not iWUE, as was our original assumption.

The obtained data are useful for the identification of evolutionary changes of the photosynthetic apparatus and for susceptible and tolerant characteristics of wheat species and can thus be used for breeding processes.

Modelling of spring barley under the conditions of normal and reduced precipitation

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This paper evaluates two-year (2013 and 2014) results of field experiments with spring barley (cultivar Bojos) under reduced precipitation supply. The field experiments were carried out at the experimental station in Domanínek (Czech Republic; 49°31.470´N, 16°14,400´E, altitude 530 m a.s.l.) and conducted by the Institute of Agrosystems and bioclimatology at Mendel Univerzity in Brno in cooperation with the Global Change Research Centre AS CR. The field experiments consisted of small plots in two variants and three repetitions. The first variant was uncovered, the second was partially covered to exclude rain throughout the whole vegetation season. For the partial covering of the plot, a material which transmits solar radiation and diverts rainwater from the coverage of the plots was used. In 2013, the covered area of the experimental plot was 30%, and in 2014, it was 70%. The main aim was to determine whether there are any differences in the spring barley's development, growth and yield in the uncovered and the partially covered plots, and a comparison of the results. Firstly, the differences of key parameters (seasonal dynamics of the leaf area index and above ground biomass, soil water content, yield components and yields) were compared; secondly, the results of the field experiments served as input data for the crop growth model DAISY. Subsequently, the crop growth model's ability to simulate crop growth and crop development affected by the drought stress was explored. The results were assessed using the following statistical indexes: root mean square error (RMSE) and mean bias error (MBE).

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Statistical forecasting model of electric energy consumption in the Czech Republic

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Precise forecasting of electric energy consumption has a great significance for the electricity industry. It helps the system operators to optimally schedule and control the power systems, and even slight improvement of the prediction accuracy can yield large savings or profits (Cancelo et al. 2008). Due to these reasons, many forecasting models, based on various principles, have been developed and studied. Because of the strong dependence of the energy consumption on the weather conditions, they often utilize outputs of numerical weather prediction models (Felice et al. 2013).

In this study, we present and analyse statistical model for forecasting of hourly electrical energy consumed by customers of the energy provider E.ON Energie, a.s. in several areas of the Czech Republic. The aim of this model is to create hourly predictions up to several days ahead with the main focus on predictions from 25 to 48 hours ahead. It uses hourly data of consumed energy from the years 2011-2014 and corresponding predictions of temperature and cloudiness provided by model Aladin/CZ (Farda et al. 2010). The statistical model is based on regression analysis applied on appropriate data samples and it is supplemented by several optional post-processing methods. Specifically, we use a robust linear regression algorithm for identification of the energy consumption dependence on temperature, which is the meteorological variable with the largest influence on the consumption. The post-processing methods focus on removing prediction bias in dependence on economic situation (represented by GDP) and on sudden temperature changes, for which they use linear regression and Kalman filter algorithm.

We analyse the presented model from the point of view of accuracy of the hourly predictions for the years 2013 and 2014. The accuracy is primarily measured by the mean square error, it is evaluated for various periods and situations and effect of the individual parts of the model on its value is shown.

References

Cancelo JR, et al. (2008) Int. J. Forecasting 24, 588–602.

Farda A, et al. (2010) Stud. Geophys. Geod. 54, 313–332.

Felice MD, et al. (2013) Electr. Pow. Syst. Res. 104, 71–79.

Assessment of urban ecosystem services and their impact on residents' well-being in the Czech Republic

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Sustainable urbanization has received growing attention in the last decade (e.g. the Millennium Development Goals or Urban Sustainable Development Goals, CBD, etc.). An integral part of the process is the presence of functional public greenery, including urban food gardens and farms in cities representing islands of natural assets. The benefits provided by these spaces are recognized to have a substantial capacity to enhance human well-being. However pressures on these green resources are increasing (MA, 2005, EEA, 2013) despite of their contribution to the creation of multifunctional urban landscapes which are of great importance for the quality of the living environment in the cities around the world. To moderate this trend, we quantify the benefits, which annihilate the value of natural spaces in cities. Our study has the ambition to narrow the remaining knowledge gap in this field, as the values of urban ecosystem services have not been adequately addressed yet. The methodological framework operationalizes the concept of ecosystem services by the identification and evaluation of ecosystem services in Czech cities. We apply a value transfer method in combination with a questionnaire survey to particularly investigate ecosystem services in five cities in the Czech Republic, their recognition by residents and public preferences towards the future management of urban green ecosystems. Based on the results and within a European context, we provide recommendations how to increase urban resilience, health, and residents' quality of life by ecosystem based adaptation options.

References

MA (Millennium Ecosystem Assessment) (2005) Ecosystems and Human Well-Being: A Framework for Assessment. Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment. Island Press, Washington, DC.

EEA (Environmental Indicator Report) (2013) Natural Resources and Human Well-Being in a Green Economy. Luxembourg, Publications Office of the European Union.

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Ecosystem services within agricultural landscapes – trade-offs and synergies

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In the last decade, the issue of ecosystem services has become a very important topic worldwide. The massive population expansion, especially in South and East Asia and South America, brings up the question of how to secure a sufficient food supply, to face poverty and mitigate the global change. In other words, what is the best way to ensure human well-being in the most efficient but also sustainable way without depleting ecosystems and natural resources (FAO, 2007; OECD, 2008). Agriculture is the greatest direct driver of change in terrestrial ecosystems, mainly through a change of land use (conversion to cropland) and an application of new technologies enhancing the yield (MA, 2005).

In our research, we focused on a provision of four ecosystem services (food provision, carbon sequestration, biological control and pollination) in agricultural landscapes, their mutual relationships and how these were affected by various agricultural technologies. We collected biophysical provision values of the ecosystem services mentioned within particular agricultural practices from studies previously carried out and found that the practices favouring carbon sequestration, biological control and pollination were particularly those of organic agriculture, absence of synthetic fertilisers and herbicides, application of organic fertilisers and cover crops, and the establishment of landscape features. Carbon sequestration was also enhanced by the absence of tillage. Yields were higher within conventional agriculture with a use of synthetic fertilisers and herbicides. The effects of zero tillage and use of cover crops on food provision were quite heterogeneous and in some cases, an application of these two practices might boost the performance of all the ecosystem services analysed.

References

FAO (2007) The State of Food and Agriculture - Paying Farmers for Environmental Services. FAO Agriculture Series (38).
MA (2005) Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.
OECD (2008) OECD Environmental Outlook to 2030. OECD, Paris, France.

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Forestry operations with a focus on different types of felling in the forests related to carbon and economic balances

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The assessment of carbon and economic balances, completed by environmental load computation using the Life Cycle Assessment method (LCA), could be a useful tool for sustainable forest management examination (e.g. Berg and Lindholm, 2005; Michelsen et al., 2008). The purpose of this study was to compare forestry operations focused on different types of felling (chain-saw and harvester) in relation to forest stands with Norway spruce monocultures and mixed forests in the research area of Novohradske hory Mts. (Czech Republic) using methods of carbon balance (including Life Cycle Assessment - LCA) and economic balance. In general terms, carbon and economic balance methods consist of the comparison of quantified inputs (fossil fuels, electricity, machinery used, fertilizers, etc., converted to emission units of carbon in t of C-CO2 –eq. or EUR) with quantified outputs (biomass production in t of carbon or EUR). The forest operations were modelled for one rotation period. The results showed that there were main differences in the emission of carbon and carbon efficiency related to forest operations with different kinds of felling. In contrast to this, the results of economic efficiency did not differ much. Differences between Norway spruce monocultures and mixed forests using the same kind of felling were very small related to the carbon balance but the differences were large in the economic efficiency (a higher economic efficiency was achieved in Norway spruce monocultures).

References

Berg S, Lindholm EL (2005) Journal of Cleaner Production 13, 33–42.
Michelsen O et al. (2008) Journal of Industrial Ecology 12, 69–81.

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Climate challenges: From risk management to opportunity in urban management

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Negative environmental impacts of the climate change on urban environments (heat-waves, water scarcity and periods of droughts) are being amplified by the current socioeconomic drivers, such as demographic trends and urbanisation, rising demand for water and growing pollution. In response to the ongoing climate change many European cities and regions have been developing strategies for the management of risks and challenges that the climate change brings along. The concept of a green infrastructure (GI) is seen as a major instrument by the European Commission to address global challenges as well as to support the quality of life in cities. The benefits of investing in GIs in urban environments are twofold. In the first place citizens can benefit from multiple ecosystem services that GIs provide. Secondly, GIs are being promoted as a cost-effective alternative or a complementary to 'grey' infrastructure and intensive land use changes (EC, 2013).

Bratislava, as one of the 21 cities selected for the EU Cities Adapt project being carried out for EC DG Climate Action (EC DG Climate Action , 2013), is currently in the phase of preparing an Action plan based on the already adopted Adaptation Strategy to Negative Impacts of Climate Change (Mayor's Office Bratislava, 2014). Nowadays green spaces in Bratislava (such as public or semi-public parks, gardens, etc.) are threatened by degradation, over-use or conversion into housing, commercial space or public facilities (Baus et al., 2014). In our contribution we investigate the potential benefits that are being delivered as ecosystem services provided by public and semi-public green spaces in Bratislava. We argue that the current management of these green spaces requires multi-level solutions, involving all relevant actors including the users (visitors) of these areas. In the cases we present, the self-organisation of local communities and efforts of local users have played a major role in enhancing and maintaining the quality of ecosystem services. We applied the theory of CPRs (common pool resources) and stated preference methods to estimate the users' willingness to pay for different management scenarios of the selected public and semi-public green spaces.

References

European Commission Directorate General Climate Action (2013) Adaptation Strategies for European Cities: Final Report, 150 p.

Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions: Green Infrastructure (GI) — Enhancing Europe's Natural Capital. Brussels: European Commission, 155p.

Baus P, Kovác U, Pauditsová E, Kohutková I, Komorník J (2014) Ecological Indicators 42, 104–111.

Mayor's Office Bratislava (2014) Stratégia adaptácie na nepriaznivé dôsledky zmeny klímy na území hlavného mesta SR Bratislavy. 71 p.

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The importance of hydromorphological analysis in evaluation of floodplain disturbances – the Upper Stropnice River case study

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This contribution deals with the comparative analysis of the hydromorphological state of river networks and the ecological status of neighbouring floodplain areas. The issue is of great importance, especially in addressing the causes and effects of flood events, as an increasingly frequent manifestation of the global environmental change at the local level. The upper part of the Stropnice River basin in Southern Bohemia with an area of about 100 km2, characterized by a wide variability of natural conditions and of human activities was the area of interest. The main objective was to analyse the nature of relationship between the level of anthropogenic degradation of the floodplain ecosystem, expressed via the representation of specific biotope types (with a point value referring to its ecological importance) and the morphological state of the river. This way it is possible to address in detail the dependence between the two variables, whose knowledge might be valuable for example in the process of determining the potential (reference) state of watercourses. The evaluation of hydromorphological conditions represents a sub-part of the overall ecological status monitoring surface water (along with biological components and selected physico-chemical parameters), resulting from the Directive of the European Parliament and Council 2000/60/EC. For the purposes of this contribution the data obtained by applying two different evaluation procedures were used – i.e. the national methodology HEM-Hydroecological Monitoring (Langhammer 2013) and the older assessment methodology developed by Šindlar (2008). The ecological status of the terrestrial part of the floodplain ecosystem was assessed using the Biotope Valuation Method (Seják, Dejmal et al. 2003), based on the system of natural habitats of the NATURA 2000 network, supplemented by an extended description of anthropogenic habitats.

Based on the results we can conclude that the direct link between rivers and their close surroundings was only minimal in the area of interest. A large anthropogenic modification of the floodplain area plays a significant role in shaping this relationship, as well as the actual riverbed, which often causes completely different results. While the floodplain ecosystem reached relatively favourable ecological values, the relevant channel reach was degraded significantly and vice versa. These facts point to the long-term effects of anthropogenic pressure, manifested with a mutually not so coordinated management of the river network and system of land exploitation within the watershed.

References

Langhammer J (2013) HEM-Hydroekologický monitoring, hodnocení ukazatelů. Karlova univerzita vPraze, 23 p. (in Czech)

Šindlar M (2008) Metodika vyhodnocení aktuálního stavu hydromorfologie vodních toků. Šindlar s.r.o., 78 p. (in Czech)

Seják J, Dejmal I et al. (2003) Hodnocení a oceňování biotopů České republiky. UJEP, Ústí nad Labem, 429 p. (in Czech)

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Comparison of forestry reclamation and spontaneous succession from plant diversity, production and economic points of view

Cudlín, O.1,2, Faigl, T.2, Plch, R.1, Cudlín, P.1

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After the completion of mining, mining companies must invest extremely high cost in the restoration of the natural landscape. However, the reclaimed ecosystems do not provide all the ecosystem services that are necessary. One of the possibilities to support biodiversity and functional ecosystems is to use spontaneous succession. The aim of our study was to determine, whether the value of the diversity of plant communities, the volume of woody biomass and partial economic balance of plots left to spontaneous succession would reach similar values as plots reclaimed by forestry. At the Great Podkrušnohorská spoil heap we established 6 pairs of permanent research plots (6 plots with spontaneous succession and 6 forestry reclaimed plots); 3 pairs were established in moist habitats and 3 pairs in mesophilic habitats. In each area of 60x25 m the total number of trees was counted. The following parameters were estimated for each species for a maximum of 20 representative individuals: total height, breast height diameter, and age of the tree. The Simpson diversity index and the amount of biomass were computed for each plot. The economic balance was calculated as the difference between the cost of creating a body of spoil heap, establishment and management of forest reclamation and theoretical profit from woody biomass. The results were analyzed by paired t-test. Populus tremula, Salix caprea and Betula pendula dominated with spontaneous succession on the wet plots, and only Betula pendula dominated on the mesophilic successional plots. Alnus glutinosa dominated on the wet reclaimed plots and Quercus petraea and Acer pseudoplatanus occurred on the mesophilic reclaimed plots. The numbers of tree species and individuals as well as the values of the diversity index did not differ significantly between plots with spontaneous succession and reclaimed plots. A higher mean volume of biomass and theoretical profit from the sale of wood were surprisingly found on plots with spontaneous succession. Irregular distances between trees and a higher tree age on plots with spontaneous succession might affect the rapid tree growth and the higher amount of biomass compared with reclaimed plots. However, from an economic point of view, both types of plots on the spoil heap were burdened with high initial investment, which is theoretically possible to last for hundreds of years. Based on our results and the opinion of other authors, it is advisable to increase the diversity and production of wood to apply spontaneous succession in restoring the disturbed landscape (Prach and Pyšek, 2001; Mudrák et al., 2010). Both types of management should be used to create a suitable mosaic of ecosystems in the emerging landscape.

References

Mudrák O, Frouz J, Velichová V (2010) Ecol. Eng. 36, 783–790.
Prach K, Pyšek P (2001) Ecol. Eng. 17, 55–62.

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This work was supported by the Ministry of Education, Youth and Sports of CR within the project INVID CZ.1.07/2.3.00/20 and the National Sustainability Program I (NPU I), grant number LO1415.

CzechGlobe academic staff in sociological perspective

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The poster presents an overview of results of a sociological research conducted at CzechGlobe in August and September 2014. The research was done as part of the EGERA (Effective Gender Equality in Research and the Academia) international project and targeted the views of administrative and academic staff of their work environment. The main objective was to discover whether characteristics such as age, gender, work position, marital status, and the presence of children affect how academic workers (researchers) assess their work environment. We focused on issues such as equal treatment, discrimination, working atmosphere, job satisfaction, assessment of academic work and others. The research was done using Limeservice, an online survey tool, to which we uploaded a questionnaire, the link to which was then sent to CzechGlobe academic staff. Fully completed questionnaires were then analysed using SPSS. The results indicate that while CzechGlobe is generally regarded as an environment providing respondents with freedom and excellent opportunities for academic growth, some of the answers are indeed affected especially by the demographic variables of age and gender. Moreover, in specific cases, age and gender (sometimes coupled by the presence or absence of children) intersect so that, for instance, childless young women are among those most dissatisfied with their income/qualifications, skills and work performance ratio. The poster presents the most pertinent findings of the study.

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New cooperative eddy-covariance site proposed in Darien-Panama, a Panamanian-Czechglobe site

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Our study evaluates the forest and wind conditions of the Darien site located in East Pacific Panama (N 8º32'49'' W 78º0'54'') in a very well leveled terrain, not higher than 200 m above sea level. The vegetation zone, known as Choco, is a part of the highest biodiversity region of the world. The forest includes trees reaching a height of 40 - 50 m and a semi-deciduous vegetation. Some studies recorded more than 120 tree species per hectare in tropical areas, and many (not recorded) shrubs, epiphytes, grasses, and vines, that are all very well mixed and combined in several layers in a tropical rain forest ecosystem. Panama possess two well-defined seasons. Until now, no permanent station of eddy covariance has been established anywhere in the country, in a suitable condition that can help to predict the effects of the global climate change in natural and planted forests. Poor conditions of agricultural land of any type have been discussed in Panama.

We try to determine the viability to use the Darien site, which belongs to the campus of the University of Panama. This is a natural 40-year old recovering tropical semi-deciduous forest, where we want to establish a permanent eddy-covariance field research station for starting to measure greenhouse gases and to monitor the global climate changes.

The proposed research is possible only thanks to the full collaboration of the staff between the University of Panama and the Global Research Centre-CzechGlobe, which is part of the Czech Academy of Sciences in the Czech Republic.

Acknowledgement *This work was supported by the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPU I), grant number LO1415.*

Selection of a new site for eddy-covariance research in Vietnam – A Vietnamese-CzechGlobe cooperation

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The estimation of forest carbon stock in Vietnam has mainly used measurement and calculation of forest biomass and carbon stock density at static moments of investigation, above and/or underground biomass, towards REDD+ activities. These studies mainly focused on planted forests, and offered limited information on forest biomass and carbon stocks in Vietnam's natural forests (Sharma et al. 2013, Vo 2014). This approach could not capture continuous rates of fluxes of matters and energy. Filling this gap, CAS/CzechGlobe and VAST/ Institute of Tropical Biology (ITB) have entered a collaboration in 2012 to promote ecosystem carbon flux studies via the eddy covariance method in Vietnam.

In 2012 and 2013, CzechGlobe and ITB started a discussion and exchange visits in the Czech Republic and Vietnam, as well as field surveys in Vietnam. A site in Bidoup-Nui Ba National Park was selected for future eddy-covariance-based flux studies based on a set of standard selection criteria. The park is unique for its biodiversity conservation. Supporting high levels of plant diversity and endemism, the park is one of four national biodiversity centers of Vietnam, and among 221 endemic bird areas (EBA) in the world.

Located in the mountainous Central Highlands of Vietnam at tropical monsoon climate, the area receives a total solar radiation of 4.8 GJ m-2 year-1; an annual mean air temperature of 18oC, rainfall of 1,800 mm/year, and relative humidity of 75–85%, with two distinct monsoon seasons in which the rainy season last from April to October and the dry season from November to March the following year (Anon 2004, Pilgrim et al. 2006). The advantage of the site is its access to grid electricity, road, and security protection. Since January 2015, a 2-D sonic anemometer with a data logger has been deployed at the site to evaluate local wind conditions.

References

Anon. (2004) Investment plan for Bi Dup-Nui Ba National Park, Lam Dong province. Hanoi: Forest Inventory and Planning Institute. In Vietnamese.

Pilgrim JD, Nguyen VX, Nguyen DX, Polet G, Truyen T, Tordoff AW, Tran MH, Peters J (Eds.) (2006) Biological Assessment of the Dong Nai Conservation Landscape, Vietnam.

Sharma BD, Vu PT, Swan SR (2013) Generating Forest Biomass Carbon Stock Estimates for Mapping the Potential of REDD+ to deliver biodiversity conservation in Vietnam.

Vo HD (2014) Study carbon stock and its commercial value of some main types of planted forests in Vietnam. Vietnamese Academy of Forest Sciences, Hanoi. In Vietnamese.

Acknowledgement

This work was supported by the Ministry of Education, Youth and Sports of the CR within the National Sustainability Program I (NPU I), grant number LO1415; and the Vietnam Academy of Science and Technology, grant No. VAST.HTQT.Sec.02/2012 – 2013.

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ABSTRACTS OF REPORTS

Activities of Workgroup 2

Cork, Ireland, 23.–24. 11. 2011; Pécs, Hungary, 11. 1. 2013

Organizers: Monika Schreiner, Marcel Jansen, Nora O'Brien, Éva Hideg
28; 10 participants

Within the UV4growth network, workgroup 2 explores the interface between plant, food and environment, and specifically studies regulation of plant metabolites by UV-B radiation. Consequently, all activites of workgroup 2 are related to this topic.

In the second project year we have organized the mini-conference „MetabolUV – Interactive effects of UV-B radiation with abiotic and biotic factors" which took place at the Environmental Research Institute of University College Cork. External guest speakers as well as workgroup 2 members presented current research results. This was combined with a World Café discussion for finding answers for our UV-B research within the context of changing lifestyles and thus changing consumer demands in respect to their desired food and to the optimization of food supply chains. Thus, this mini-conference aimed to explore challenges and opportunities for ongoing UV-B research by addressing questions such as

- Which kind of food is demanded by the consumer in future? What are the consequences for our UV-B research?
- What are the relevant questions that our future research needs to address, e.g. new research topics, new collaborations and new research approaches?
- What are the consequences of our UV-B research for the future horticultural practice, e.g. new technologies, new applications, new crop management strategies?

As result of the MetabolUV mini-conference we published a book of abstracts, a vision paper and a review paper (Schreiner, M.; Mewis, I.; Huyskens-Keil, S; Jansen, M. A. K.; Zrenner, R; Winkler, J. B.; O'Brien, N & Krumbein, A. 2012. UV-B induced secondary plant metabolites – potential benefits for plant and human health. Crit. Rev. Plant Sci. 31, 229-240). These outcomes reflect future strategies in UV-B research for both – the science community and the horticultural related companies.

In the third project year our aim is the publication of a review article about UV-B induced changes in the plants' profile of phenolic compounds discussing the structure of this paper at the Institute of Biology of University of Pécs in January 2013.

Moreover, we are collaborating within the trans-European experiments of UV4growth such as the *Lolium perenne* experiment, the Grapevine Ultraviolet Network (GUN) and the planned Arabidopsis experiment.

Reported by

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Plant responses to UV radiation: from individuals to ecosystems

University of Girona, Girona, Spain, 25th–26th April, 2012

Local organizers: Laura Llorens and Dolors Verdaguer

28 participants

This conference was organized in the frame of WG4 with the aim of scaling UV effects from plants to communities and ecosystems in the context of climate change. Sessions were organized into four key themes: 1) UV interactions with other abiotic factors: effects on plant growth and metabolism, 2) UV effects on plant-animal interactions, 3) changes at the ecosystem level in response to UV and 4) cryptogams and UV: impacts and interactions. Regarding topic 1, results from several speakers showed that negative effects of water deficit on leaf photosynthetic rates and/or plant growth were, at least partially, ameliorated by UV radiation. Conversely, it was also reported that UV-B inhibition of shoot elongation was substantially enhanced when UV-B was given in combination with low temperature. The importance of UV-A and PAR regulating UV-B effects was also highlighted. Talks on topic 2 gave examples of how changes in UV levels can alter the behaviour and performance of plant pollinators, herbivorous insects or pathogens. For instance, it was shown that UV-deficient environments reduced the population growth and spread of aphids, the population density of thrips and the incidence of thrips-borne viruses. However, reproductive success of some pollinators was also reduced under UV-exclusion. Other insects or pathogens were not so sensible to these UV-deficient environments. Concomitantly, plant pre-exposure to moderate UV-B doses had positive or negative effects on insect or pathogen performance depending on the species. At the ecosystem level, results from high latitude experiments suggested limited effects of enhanced UV-B exposure on enzymatic decomposition of litter and VOC or net CH4 emissions, while dark respiration was slightly reduced under increased UV-B levels. Regarding topic 4, speakers emphasized that little is known about the UV-B mediated changes in cryptogams. Lichens and bryophytes seem to be UV-B-tolerant, in some cases due to the accumulation of protecting UV-B absorbing compounds (UACs). Nevertheless, in the case of lichens, data support a PAR- rather than a UV-B-protective function of some of these UV-B-induced compounds. In the case of the liverwort *Jungermannia exsertifolia*, specific UACs were proposed as UV-B biomarkers. Some of the identified outstanding questions for the next years were related to the evolutionary role of UV, the interactive effects of UV and climate change factors on whole ecosystem processes, and the influence of UV on the complex interactions of plants with pollinators, pests, predators/parasitoids, pathogens and related microorganisms. Findings also highlighted the need to perform long-term field experiments, especially at mid- and low-latitudes, integrating different approaches by means of multidisciplinary research teams. New experimental systems need to be designed in order to analyse better the interactions between biotic and abiotic factors.

Reported by Laura Llorens, *laura.llorens@udg.edu*
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WG4 review group; UV-B and plant reproduction

University of Girona, Girona, Spain, 25th of January, 2013

Local organizer: Laura Llorens
5 participants

This meeting was organized by WG4 to review the role of UV-B radiation on plant sexual reproduction of higher plants, both in terms of plant responses, but also in terms of relevant plant-animal interactions for plant reproduction, such as pollination, florivory or seed dispersal. To understand the effects of UV-B radiation on plant reproductive processes it is crucial to predict population level responses to UV-B changes. However, the role of UV-B at the organismal level remains unclear, with highly variable responses to UV-B changes being reported. Given the increasing realization that UV-B is a regulator rather than a stressor, there is a need to summarise and re-appraise the existing data on UV-B effects on plant reproductive processes. In this review, emphasis will be on discussing reported UV-B effects on floral traits, flowering phenology, pollination success, fruit and seed production and quality, florivory and frugivory, and UV-B-induced compounds involved in flower and fruit colour, as well as in protection of reproductive structures against UV-B. Agricultural implications of UV-B effects on plant reproductive aspects will also be assessed. Ultimately, we aim to identify those gaps in our current knowledge that deserve further attention in future research.

Reported by

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MetabolUV: Interactive effects of UV-B radiation with abiotic and biotic factor

University College Cork, Cork, Ireland, 23th–24th November 2011

Organizers: Marcel Jansen, Nora O'Brien, Monika Schreiner

28 Participants

A total of 28 delegates from 10 countries participated in a lively and stimulating meeting. The contextual frame-work within which innovations with respect to UVB will occur was outlined at the beginning of the conference. Between now and mid-century, world population will increase by 30% and become more urbanised. However, in Europe the population number will not increase, the median age will rise significantly and nutrition related non-communicable diseases (NRNCD) will become even more relevant as major causes of mortality. Thus, UVB innovations that can enhance the nutritional attributes of plant foods will be particularly relevant. Specific UVB innovations were highlighted that stimulated the accumulation of flavonoids in Arabidopsis thaliana; that modulate levels in grapevine leaves of selected stilbenes, flavonols and flavan-3-ol and also modulated phenolic compound synthesis in grape berry skin; that modulate glucosinolate accumulation in broccoli florets with evidence suggesting that consumers may be willing to pay a premium price for such phytochemical enhanced products; that significantly increased the levels of phenolic compounds with antioxidant potential in Suncrest peaches. Additionally, presentations were given on the effects of UVB on carbohydrate-containing molecules that can have an antioxidant role as well as contributing to sweetness; an overview on EU COST926 on the health benefits and safety of bioactive plant compounds; evidence on 5 fold greater accumulation of singlet oxygen neutralizing flavonoids in sun-exposed linden leaves compared to shade leaves; evidence that ecological relevant UVB doses result in the accumulation of specific glucosinolates in broccoli sprouts which could be related to transcription of specific genes; demonstration that temperature influences the effects of UVB treatment on the flavonoid profile of kale; and the interactive effects of drought stress and UVB on secondary metabolites in lettuce. There was also a very stimulating presentation on the factors influencing the transfer of findings from UVB research to primary end users in the horticultural greenhouse industry. End users are interested in practical issues such as crop yield and quantity, reduced use of pesticides, reduced labour and energy costs.

Following completion of the formal presentations, relevant issues were debated in a very lively World Café session which focused on challenges and opportunities for UVB research and identification of gaps in our knowledge base. The key outcomes of this session relevant to stakeholders included: the need to determine appropriate UVB doses and sensitivities for different varieties of fruits and vegetables, and the need to determine the anti-microbial effects and the bioavailability of newly produced plant metabolites; the need for multidisciplinary research involving input from all actors in the food supply chain; the need to disseminate a positive message on the potential benefits of UVB to decision makers including politicians, regulators and industry; the potential of UVB to be used in conjunction with other modulators of plant metabolism (CO_2, ozone, NO_2) needs to be further investigated; the need to identify new biomarkers for UVB regulation in plants; the need to develop high-tech greenhouses and urban horticulture systems including UVB technology; the need to investigate further the potential of UVB to contribute to the creation of new functional foods and nutraceuticals. The Book of Abstracts and a Vision Document arising from the World Café session are published on the UV4growth web-site.

Reported by

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School of Food and Nutritional Sciences, University College Cork, Ireland

Report on the UV4growth Mini-Conference "Acclimation to UV-B"

University of Glasgow, Glasgow, UK, 1st – 2nd of May, 2012

Local organizers: Hauser, M.-T., Jenkins, G.

28 participants

The mini-conference focused on the molecular and cellular mechanisms of UV-B perception, signalling and gene regulation, and the various downstream responses that underpin acclimation to UV-B. It included presentations on the structure and regulation of the UV-B photoreceptor, UVR8, functional characterizations of various UV-B controlled genes and proteins, UV-B induced damage to the photosynthetic apparatus and the DNA, natural variations of growth upon exposure to chronic and mutagenic doses of UV-B, the gene expression and metabolite accumulation behaviour of UV-B photoreceptor mutants in natural environments, the interaction between UV-B and other abiotic factors and the epigenetic regulation of the crosstalk between bacterial infection and UV-B responses.

Reported by

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The Horizon2020 writing group: Preparing a UV4growth 'Position paper' for lobbying plant/UV related research projects into the EU funding schemes

TG2–meeting, Copenhagen University, Copenhagen, Denmark, December 19, 2012

Organiser: Åke Strid
6 participants

As revealed from the TG2 meeting with stakeholders in Lancaster, UK, in the spring of 2012 (presented elsewhere), there is a considerable interest among stakeholders to exploit the beneficial effect of UV radiation on plants to increase competitiveness and profitability of European plant-based industries. Of special interest are the prospects of using UV radiation as an environmentally friendly plant growth regulator, as an inducer of secondary metabolite production important for health, taste and colour. Furthermore, systematic research is needed for using UV radiation as a regulator of the phytonutrient content, as well as for its potential in pest and disease control. Agriculture, horticulture, viticulture and silviculture may all benefit to different degrees from supplementary UV radiation.

To be able to fully take advantage of the benefits of UV radiation in commercial production, considerable applied research efforts are needed to develop best practice guidelines and approaches for the purposes mentioned above. Research is needed for different plant species, in different settings and regimens, and with different 'sources' of UV (e.g. by using glass houses fitted with UV transparent cladding material, UV emitting tubes, or UV emitting LEDs). To be able to get substantial multilateral support for such applied research efforts, it is important that UV-associated research programmes are included in upcoming calls within the EU research Horizon2020 framework in the near future. Therefore, the UV4growth Managing Committee decided on forming a writing unit within the Stakeholder interaction technical group (TG2) with the purpose to produce a 'Position paper' describing the advantages of including a research programme in the EU framework regarding the use of UV radiation as a regulator of crop quality. The ultimate aim with such research is to bundle the progress delivered by the European applied plant photobiology research community for the benefit of the competitiveness of European plant-based industries. In addition, the writing unit aims at identifying organizations and individuals, in Brussels and in each member country, which can help to integrate UV related research programmes into future calls.

A first meeting of the writing unit was held in Copenhagen in December of 2012 and the presentation will outline the work in progress and discuss the possibilities with the approach.

Reported by

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WG3: Plant Responses to Ultraviolet Radiation – Roles of Antioxidants and Pro-Oxidants

Copenhagen University, Copenhagen, Denmark, 2–3 February 2012

Organizers: Riitta Julkunen-Tiitto, WG3 leader (Finland), Eva Rosenqvist, assistant WG3 leader, local organiser (Denmark), Petra Majer, junior assistant WG3 leader, abstract book editor (Hungary), Éva Hideg, scientific organiser (Hungary), Fernando Cebola Lidon, scientific organiser (Portugal)
34 participants

Traditionally, plant stress physiology has been regarding reactive oxygen species (ROS) and other free radicals as malevolent and to be annulated by antioxidants. Discovering ROS (mainly H_2O_2) mediated defence against a variety of stress conditions, such as high intensity visible light or biotic stressors have refined this bipolar image. A new, advanced model of plant-environment interactions includes a dynamic balance between ROS and ROS scavengers, between pro-oxidants and antioxidants and thus allows researchers to distinguish between acute and chronic effects. Similarities between responses to acute UV radiation and other unfavourable abiotic conditions have lead to the assumption that ROS may also play a positive role in plants' responses to UV-B. Studies on UV acclimation, of which several are carried out within our COST Action UV4growth, demonstrate a regulatory role of UV radiation and a specific UV photoreceptor has already been identified (see reports on WG1 activities).

The meeting organised by WG3 aimed at reviewing recent developments and identifying new challenges, focussing on the role of pro-oxidants in responses to low, environmentally relevant UV doses. Part of the meeting included reports on effects of high UV doses triggering acute effects; because biochemical responses under such conditions are easily accessible by existing methodology. An important question is the relevance of these, i.e. whether reactions to high or even mild (non-lethal) stress are relevant to adaptive responses. Sensitivity of ROS detection is clearly a limiting factor and finding new methods has been identified as one of the new challenges. When presently available direct ROS detection is insufficient, evaluation of antioxidant responses either directly or based on gene expression patterns were found to be a useful and available alternative. The importance of theoretical, physico-chemical calculations in identifying possible products of ROS reactions *in vivo* has also been recognised. Several talks showed the importance of the plants' antioxidants status and genetic background in adaptive responses. Open questions included whether regulatory pathways involved ROS responsive elements, either as responses triggered directly by ROS or via activating antioxidants.

Results from a number of talks from this meeting, together with work from other UV4growth associated laboratories were published in a special issue of the Emirates Journal of Food and Agriculture, with Fernando Lidon as guest editor.

Representatives of three companies (Lemna Tec GmbH Germany, Agilent Technologies Sweden and Force-A France) were also present: gave short talks, provided product information and also participated in discussions. The non-invasive optical instrument capable of estimating leaf flavonoid content of Force-A inspired WG3 members to organize a separate small meeting on the use of this technology in UV research.

Reported by Éva Hideg, *ehideg@gamma.ttk.pte.hu*
Institute of Biology, University of Pécs, Pécs, Hungary

WG3: Development of trans-European wine-leaf experiment – GUN (Grapevine Ultraviolet Network)

University of Pécs, Pécs, Hungary, 10 January 2013

Organizer: Éva Hideg (Hungary)

12 participants

The aim of the meeting was to establish a trans-European network, connecting – but not restricted to – COST UV4growth associated laboratories investigating the effects of UV radiation on grapevine. The first activity, which has already started before the meeting of this Grapevine Ultraviolet Network (GUN) was to sample grapevine leaves from six locations. Pinot Noir leaves were collected at the same developmental stage (veraison, the onset of ripening) from Austria, Greece, Hungary, Italy and Spain (2 locations). Freeze-dried leaf samples were redistributed among laboratories measuring various metabolites known or assumed to be linked with responses to UV. As most laboratory measurements were still in progress at the time of the meeting, the group only discussed preliminary results. In addition, sampling strategies were reviewed and the addition of new geographical locations for the second sampling year (year-4 of the UV4growth Action) was agreed on. The aim of the ongoing and planned experiments is, in addition to exchanging information among laboratories of similar interest, to search for correlations between UV irradiation during development and acclimative physiological responses. A special emphasis is given on potential UV absorbing compounds and antioxidants.

The first round of experiments will be completed by late spring / early summer of 2013. A second round of sampling will take place during the summer of 2013 which will be followed by laboratory work in 2013–14. A comparative discussion of results will be published at scientific forums, at conferences and as a journal article.

GUN members also discussed the importance of disseminating aims and results and decided on writing a popular science brochure on potential beneficial effects of UV on grapevine development in the vineyard and on the quality of products such as table grapes or wine. This material will be developed into information for potential partners (for example growers participating in vineyard experiments), policy makers or educators. As a start of this work, a short 2–3 page text was outlined, which on completion was planned to be translated to several languages for publication in national viticulture or horticulture journals.

There were five ESRs among participants of this meeting, all participating in at least one but mostly more of GUN activities: sampling, laboratory measurements, data analysis and public dissemination.

Reported by

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Institute of Biology, University of Pécs, Pécs, Hungary

WG3: Review ROS/Antioxidant Protocols

University of Pécs, Hungary, 10th November 2012

Organizer: Prof. Éva Hideg (Hungary)

Attendees: Prof Åke Strid, Prof Sonja Veljović Jovanović, Ms Petra Majer, Ms Marija Vidović, Mr Gyula Czégény

The meeting organized by WG3 aimed to discuss good practices in various antioxidant and radical measurement techniques relevant to UV research and reviewing all troubleshoots which can appear during these analyses. ROS (e.g. hydrogen peroxide and singlet oxygen) have been implicated as signalling molecules in a number of processes under unfavourable abiotic conditions. Similarities between antioxidative responses to acute UV radiation and other abiotic stresses have lead to the assumption that ROS may also play a beneficial role in UV acclimation. Therefore, we focus on the importance of exact determination of ROS and antioxidants in responses to low, environmentally relevant UV doses. Apart from avoidance of possible pitfalls during extraction and measurements, emphasis should also be on theoretical physico/chemical calculations of possible concentrations of ROS and other free radical products generated *in situ*, which should also include UV-dose response curve. A summary of techniques, merits, disadvantages and possible pitfalls will be published as a review. The main aim of participants is to publish a journal review on ROS/antioxidant protocols in Free Radical Research. In addition to the scientific paper, a popular science summary will also be prepared, to be distributed within the Action, either as stand-alone output (good practice guidelines) or as a part of other dissemination material. The proposed review should contain the following sections:

I. Introduction on UV-B effects the role of pro-oxidants and antioxidants in responses to low, environmentally relevant UV doses;

II. The importance of proper sampling including possible redox reactions occurring in plant tissue extract;

III. Discussion on the methods (direct vs. indirect approaches, gene expression, protein and activity data, measurements of non-enzymatic antioxidants, total antioxidant capacity);

IV. Conclusions (impact of the pitfalls on discussion of regulatory pathways involving ROS and antioxidants).

The manuscript will be finalized at the second meeting and is planned to be submitted for publication before the end of COST year-3. Half of the team are ESRs (all PhD students) who will be active in writing sections either alone or paired with more experienced researchers. The next meeting concerning the finalization of the „draft" manuscript will take place at Belgrade.

Reported by Sonja Veljović- Jovanović, *sonjavel@imsi.rs*, *sonjaveljov@gmail.com*
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All that you wanted to know about UV radiation

Alenka Gaberščik[a], Alan Jones[b], Marcel Jansen[c]

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The attitude of public towards UV radiation is usually negative. The majority of people relate UV radiation to sun burns and skin cancer, while there is little awareness of the importance of UV-B radiation for life on the Earth. The "Educational Group of UV4growth" aims to summarise the benefits of UV-radiation for different levels of life on our planet as an educational text titled "All that you wanted to know about UV radiation". The text with the questionnaire (test) will be available on UV4growth web page and in a form of an article published in an educational journal. The following aspects will be included in the text:

1. UV radiation ends where the colours of the rainbow begin.
   - The nature of light.
   - What is UV radiation?
2. UV radiation and plant photosynthesis enable the existence of protective ozone layer.
3. Light shaped the life on the Earth.
   - During evolution organisms adapted to their environment. UV radiation has been just one out of many environmental factors.
   - The colour of the Earth is not like it seems to be (different visions in different organisms).
   - Plant can "see" UV radiation and response to it through changes of plant chemistry, physiology, morphology, primary productivity.
   - Plants used the advantage of UV for advertising:

     – secret paths leading to delicious food are visible only to selected insects (pollination).

     – the advertisement could also be a trap (carnivorous plants).
   - UV induced substances in plants provide protection against pests and stress for plants.
   - Under normal UV conditions is not harmful for plants, except in poorly adapted (unhardened) plants and under stressing conditions UV-B cause damage (for example in cultural plants).
4. Benefits for humans:
   - UV irradiated plants are healthier food (growth of agricultural plants in the field vs. culturing in the greenhouses).
   - UV might increase the amount of active substances in medical plants.
   - UV-A and visible light enable the repair UV-B caused DNA damage.
   - UV-B radiation is responsible for the production of vitamin D in our skin that is related to human health.
5. How "burning" is increased level of UV-B radiation today?
   - Plants increase the production UV-B screen to protect themselves (induction of the synthesis of phenolic substances by UV-B radiation).
   - Changes of plant biochemistry, morphology, phenology, reproductive effort might have effect on other trophic levels (pollinators, carnivorous plants, decomposers).
   - Negative effects on productivity are found in many agricultural plants, but rarely in plants from natural environments.
   - Plants under stress are more sensitive to UV-B, while UV-B increase plant resistance to drought.

WG3 Review Plant Morphology: Interpreting photomophogenic responses to UV-B radiation

Global Change Research Centre, Brno, Czech Republic, 6th October 2012

Organizers: Otmar Urban and Karel Klem
4 participants

There is a need to reappraise the effects of UV-B radiation on plant morphology and photomorphogenesis in view of the improved mechanistic understanding of UV-B effects, and especially the elucidation of the UVR8-photoreceptor and associated signalling pathways. This development coincides with a paradigm shift, away from considering the damaging consequences of increased UV-B due to ozone depletion, towards exploring the role of UV-B among a suite of environmental signals received by plants. This change in emphasis necessitates a re-evaluation of the existing literature in an attempt to distinguish generic UV-B stress responses from UV-B-mediated regulation.

This review group tried to establish the connection between molecular and cellular level processes occurring throughout plant development and the most-commonly reported effects on morphology at an organ and whole plant level. The results of field and controlled-environment experiments with realistic UV-B doses indicate that detrimental effects of solar UV-B for plant growth and fitness are uncommon. However, species-specific differences in morphological responses to UV-B can be expressed over long-time periods, and may indirectly alter plant community composition, which in turn can lead to dynamic changes in ecosystem processes. From a practical viewpoint, UV-B-mediated changes in plant growth, allocation and yield are crucial for agricultural production, and can lead to both commercial applications (e.g. use of targeted UV lamps).

This review group will identify gaps in our capacity to scale up from molecular to whole plant level morphological UV-B responses, and will enhance our ability to interpret the results of experimental manipulations and responses to environmental gradients in solar UV-B. An important outcome is that future studies need to distinguish high-dose UV-B-induced effects causing a general plant stress induced response (SIMR), from regulatory UV-B effects (UVR8 pathway) that are expressed as UV-specific photomorphogenesis.

The outcome of this synthesis of ideas will be published as a review article authored by Karel Klem, T Matthew Robson, Otmar Urban, Marcel Jansen.

Reported by Matthew Robson, *matthew.robson@helsinki.fi*
University of Helsinki, Finland

Molecular toolkit for applied UV-B research

Max Planck Institute for Plant Breeding Research, Cologne, Germany, 5.–7., February, 2013

Ales Pecinka, Thomas Piofczyk, Istvan-Zoltan Vass
13 participants

The school „Molecular toolkit for applied UV-B research" was organized to teach young researchers, mostly from non-molecular fields, widely applicable techniques to study plant molecular responses to UV-B.

The practical training focused on the detection of pyrimidine dimers using digestion with T4 Endonuclease V and on identification of UV-B induced cell death. The main part of the school dealt with analysis of gene expression by quantitative PCR. The participants isolated RNA, tested its quality, synthesized cDNA, prepared samples for quantitative PCR and analyzed expression of several genes known to change their expression in response to UV-B stimulus. Since quantitative PCR is a method of choice for analysis of a short list of candidate genes, we also presented how gene expression can be analyzed at a genome-wide scale using technically advanced methods of next generation sequencing. The participants were provided with protocols that should allow repeating these experiments at their home institutions. Several potential collaborations and research visits at the Pecinka lab were planned.

Reported by

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Beyond the Visible: A handbook of best practice in plant UV photobiology

Pedro J. Aphalo
17 authors, 6 editors

Even though included as an activity in the original application, at the Szeged meeting some of us realized the urgent need for guidelines on experimental methods to be used within our action. The original idea was to write a paper, not a handbook. However, as planning progressed it became self evident that in addition to a list of guidelines, a handbook of methods was needed. Work started within the TG on UV technology but later other expert co-authors were invited to participate.

We hope this publication will be useful to researchers within and outwith our COST Action. The guidelines should work as checklists during design of experiments and when manuscripts are reviewed. The methodological and introductory chapters justify these guidelines and describe methods in detail.

We tried to achieve a balance between completing the handbook quickly and making it comprehensive. Readers will be the judges on whether we have succeeded or not. The electronic version of the handbook is available through open access, and the paper version printed in full colour at a relatively cheap price. We hope this will provide easy and wide access to our work.

A summary of the guidelines to be published as an article in a journal was originally planned. Given the size of the handbook this seems very challenging, but will be attempted.

Aphalo, P. J.; Albert, A.; Björn, L. O.; McLeod, A.; Robson, T. M.; Rosenqvist, E. (eds.) 2012. Beyond the visible: A handbook of best practice in plant UV photobiology. COST Action FA0906 UV4growth. Helsinki: University of Helsinki, Department of Biosciences, Division of Plant Biology. ISBN 978-952-10-8362-4 (Paperback), 978-952-10-8363-1 (PDF). xxx + 176 pp.

Permanent URI to the open-access repository of the University of Helsinki: *http://hdl.handle.net/10138/37558*

http://uv4growth.wordpress.com/handbook/ is a blog with news about corrections and printings, and links from which the R packages used in the handbook can be downloaded. There are also links to sellers of printed copies.

Reported by

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Flavonoid protocol meeting in Helsinki

University of Helsinki , 00014 University of Helsinki, Finland, 19th–20th November 2012

Organisers: Riitta Julkunen-Tiitto, Mathew Robson
6 participants

The aims of the meeting in Helsinki was to discuss generally the need of the flavonoid protocol review, detailed content of the review and share the tasks to authors based on their research fields. It was decided to write the review of several chapters including sampling, sample prehandling, extraction and purification, quantitative and qualitative analyses using non-destructive and destructive methods. The emphasis was on standard operation methods to facilitate the comparison of flavonoid results to be published in future.

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Improving protected crop production by exploiting plant responses to solar ultraviolet light: a meeting to connect research and end-users

TG2–meeting, Lancaster University, Lancaster, UK, April 29 – May 1, 2012

Organisers: Nigel Paul and Marcel Jansen
20 participants (from both industry academia)

Increasing understanding of how plants respond to UV has revealed that there is substantial scope for exploiting those responses in crop production. Effective exploitation of UV responses can improve crop morphology, regulate growth, improve taste, colour, and phytonutrient content, and increase pest and disease tolerance. It is already possible to manipulate crop exposure to UV by the use of cladding materials (plastic films, mesh or glass) with specific UV transmission properties. UV-light sources are routinely used in research, but in the future, LEDs may offer a new route to deliver targeted UV treatments in a commercial environment. Despite the potential of UV radiation as a new tool in crop production, uptake by growers remains relatively limited. The intention of the UV4growth Lancaster-stakeholder meeting was to be a forum for discussion between researchers (applied and fundamental) and a range of „end-users", such as growers, consultants, suppliers of plastics or mesh, or lamp manufacturers. Presentations focussed on robust but easy-to-use UV-meters that can be used in the industry, UV-effects on plant morphology that may decrease dependancy on chemical growth regulators, UV-effects on phytochemicals that improve health-benefits, colour, and/or flavour, UV-manipulation as a tool for disease management and UV-effects on plant hardiness, and especially transplant quality. Examples of pre-harvest (supplemental lighting, filtering and UV-reflective mulches) and post-harvest UV exposure were given. The advantages of using UV-transmitting plastics in the Mediterannean were shown, including improved quality produce for a range of crops. There was also a report on the use of UV-C for disease control by a commercial grower. Discussion focussed on how the various opportunities map on to key commercial needs for different crops and regions, and especially on identification of major constraints for the wider exploitation of UV-responses. The meeting generated a clear message that;
(1) UV-responses are potentially commercially interesting, but that different sectors are interested in different aspects (i.e. morphology vs phytochemicals vs disease control).
(2) there is an urgent need for more applied research that translates the understanding obtained using Arabidopsis to relevant crop species.
(3) there is a strong need for more accessible information focused on commercial crops.
(4) there is a niche market for plants with increased phytochemical content, but cost-benefit research is required.
(4) health safety issues need to be addressed, particularly where supplemental UV is used.
Outcomes of the meeting include a grower-targeted text, informing about opportunities to exploit UV-responses, and published in multiple languages in horticultural press. Plans for a follow-up meeting in year 4 to look in more detail at aspects of UV-responses, and to explore funding for applied research.

Reported by

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The Trans-European Arabidopsis experiment

Gwynn-Jones, D.[1] and Hauser, M.-T.[2]

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Arabidopsis thaliana L. will be grown in early May 2013 across a latitudinal gradient in Europe to assess how climatic factors dictate variation in plant development, growth and leaf chemistry. Using a large geographical spread of sites, we will assess how natural ultraviolet radiation exposure interacts with other factors to influence A thaliana plant success. The accession Col-0 A. thaliana and the non-transgenic uvr8 mutant will be initially employed as a feasibility study towards a larger experiment in 2014.

In May 2013 seeds from both accessions will sown and grown in standardised compost, thinned to three plants per pot for growing outdoors at each site (n=8 per accession) Plants will be grown in open but wind protected areas and regularly watered. Participating groups will assemble and contribute climatic and UV radiation data over the plant growing period (from nearby meteorological stations) for subsequent interpretation of plant responses.

Rosette development will be photographed and leaf area estimated every seven days with the plants harvested after 28 days since introduction to the field. Harvested material will be separated into rosettes, inflorescences for their fresh weight and measurement of inflorescence length. Roots will be carefully separated and washed and all plant material components air dried at 40oC. UV-absorbing compounds, glucosinolate and flavonols will be measured from ground rosette tissue. Responses and interactions according to accession and location will be analysed via two way ANOVA with multiple regression analyses used to indirectly assess the relative importance of climatic factors on A. thaliana performance.

Reported by

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Author's index

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