Newsletter
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CzechGlobe
Global Change Research Centre AS CR, v. v. i.

CZECHGLOBE IS GAINING MOMENTUM

It hasn't been long since we were evaluating year 2012 on the pages of CzechGlobe Newsletter, and now almost half of 2013 has already passed again. It seems that the magic number thirteen in the year 2013 does not necessarily have to be unlucky for us. Events at the CzechGlobe Center are gaining momentum, which has reflected in many organized conferences of international importance.

In terms of meeting the RDI project objectives, undoubtedly, there have been two major things. The first one is the purchase of the CESSNA aircraft for the airborne laboratory belonging to the Department of Remote Sensing. This successfully completed the nearly four-year-long ordeal associated with planning the purchase of the aircraft, its technical specifications, laying out its operating costs and flying hours, putting across and reasoning its usefulness as well as its effectiveness within the CzechGlobe project, and last but not least, with the successful selection procedure. The aircraft called Lidka has already been introduced to the public at the traditional Helicopter show in Hradec Králové and is currently being technically modified for the use in airborne sensing. The second significant event was the ceremonial opening and launch of the Atmospheric station in Křešín near Pacov. The mast, which, with its 250 vertical meters, belongs among the tallest constructions in the Czech Republic and has thus become the tallest construction built for scientific purposes, will mainly serve as a National monitoring spot of the occurrence and long-range transmission of greenhouse gases. The event, where the President of the Vysočina Region – assisted by the news crews – officially cut the ribbon, and which was attended by the representatives of the Academy of Sciences, cooperating universities and the leader of the ICOS Atmospheric Thematic Centre Michel Ramonet, was held concurrently with the 25th anniversary of the Košetice Observatory. This observatory is in close vicinity of the Atmospheric station. The interconnection of the station with a traditional CHMI Observatory with existing long-term records of meteorological measurements as well as air quality measurements underscores its importance and quality even more.

These lines were written shortly after the Czech Republic and neighboring countries suffered disastrous floods, which are bound to raise debates on whether these floods happened due to the climate change and how it actually is with all the global warming. Thus, there are still plenty of tasks and ideas for useful work at CzechGlobe, as well as lots of issues to contemplate about.

Summer is ahead and so is the holiday time, so there is nothing more to say than to wish you all a nice summer time without any extreme weather events.

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We are introducing the Department of Remote Sensing

REMOTE SENSING CONTRIBUTES TO THE OBJECTIVITY OF THE INVESTIGATION OF THE EARTH

Says the Head of the Department of Remote Sensing, which belongs to the Global Change Research Centre AS CR, p.r.i., František Zemek. He graduated from the Faculty of Sciences in Brno in the subject field of Mathematics and from the University of Agriculture in České Budějovice in the subject field of Phytotechnics. He habilitated in the field of Applied and Landscape Ecology at the Faculty of Agriculture of the University of South Bohemia in České Budějovice, where he now lectures.

What would you start with when characterizing remote sensing?

I'd start with its physical principle. It actually is a measurement of electromagnetic radiation reflected from the Earth's surface or radiation emitted by this surface and captured by optical sensors placed on aircrafts or satellites. The total spectral range of electromagnetic radiation which remote sensing works with, starts around $4{,}10^{-7}$ m (hundreds of nanometers) and ends around 10^{-1} m (tens of centimeters). For comparison, the sensitivity of the human eye is in the range of 400–700 nm. Thus, remote sensing can see what remains invisible to the human eye.

Do all sensors have such a wide spectral range of sensing?

Certainly not. The construction of scanners is determined by the purpose of their use as well as by current technical possibilities. I would compare it to the common photograph. A black and white image captures the only wide range of the visible spectrum. However, a color photograph captures (without the user knowing) the object in three wavelengths – blue, green and red parts of the spectrum. Technically, such a record captured is called a multispectral image, which may generally include even several tens of wider wavelength ranges. From here, there is just a step to hyperspectral (HS) imaging, which captures data in the range of tens to hundreds of very narrow channels. All of the above mentioned scanners are so-called passive devices. They record the radiation reflected from the Earth – its main source is the Sun. While active scanners themselves emit a signal of known properties and accept it back after its interaction with objects on the Earth's surface. Based on changes of the signal we deduce the properties of objects, or based on the time that takes the signal to return, we deduce the distance of objects from the sensor. This group of devices includes well-known RADARs, and more recently LiDARs.

What do you think makes remote sensing unique and irreplaceable?

It's a number of its properties. Besides the already mentioned „sight" beyond the range of human vision, remote sensing is the only system that is able to capture a current situation on the Earth's surface over a large area using the same method. And then it is also able to quantitatively evaluate it for a specific purpose using the same methodological procedure and to present the results visually. Remote sensing can work at different spatial scales and with a different spatial information detail. We can remotely capture and evaluate data from a small area of interest, such as condition of forest stand or agricultural crops in a selected vegetative stage at the level of several hectares or square kilometers, with a detail of the object resolution in the range of centimeters or meters. On the other hand, the periodically sensed data from satellites enable us to obtain information about the state and processes taking place all over the Earth's surface. The time interval between the two „visits" of the satellite at the same location on Earth and its scanning is from 16 to 2 days depending on the purpose of the satellite. No other tool is able to provide us with such information. Considering that the first series of satellites with their periodicity of 16 days started its activities in 1972, we have unique more than forty-year-long standardized time series of data, which can provide us with credible evaluation of processes and changes that have taken place on the Earth's surface, including the one that we call the global change.

Could you provide us with a specific example of the evaluation of the global change using remote sensing data?

Perhaps the most visible examples, both at the global and regional scale, are the changes in land use. They are, for example, increases in built-up areas at the expense of formerly used agricultural land or changes to forest cover over the last 40 years, which were elaborated by NASA in approximately ten-year-long period for the entire globe. Similarly, most conclusions on the areal and elevation changes of glaciers cover are derived from satellite data as well as evaluation of changes in substance concentrations in the atmosphere, such as ozone. As for the territory of the Czech Republic at the ecosystem level, I'd rather not talk about the global change, but about trends that can be assessed from satellite data. Examples include the „resurrection" of forest stands in the Ore Mountains/Krušné hory and the Giant Mountains/Krkonoše after the year of 1990 – after their dieback due to air pollution from thermal power plants in the 60–80s of the last century.

Does it mean that your Department of RS deals mainly with the evaluation of satellite data?

It does not. Of course, we use some types of satellite data in research projects, particularly when evaluating the above-mentioned time trends. This is how we, for example, used the time series of satellite date when we were assessing the development of bark beetle infestation of spruce forests in the Šumava Mountains, and how we determined the course of spatial spreading of the calamity from its beginnings to the present. However, since 2006 our main research activities have been focusing on airborne remote sensing. For this purpose, we created a laboratory equipped with an airborne hyperspectral scanner, to date the only facility of its kind in the Czech Republic.

What are the main issues your department addresses and how do you use the data provided by this device?

Most activities are focused on assessing the current state of ecosystems using hyperspectral data, supporting field measurements and mathematical modeling methods. The practical results of the evaluation are methodologies for processing image data for a specific purpose. And graphic outputs are thematic maps that quantitatively display a specific biochemical parameter, such as concentration of chlorophyll in the forest foliage. From such maps we can deduce the health of the stand and its photosynthetic potential, e.g. how much CO_2 can the given forest type sequester and store in the form of root and shoot biomass. Returning to the example of bark beetle calamity, satellite data provided us with information on when the forest died, and we used hyperspectral data for the evaluation of the current state of the stand regeneration. While satellite data are shared by a large community and its processing is mostly carried out using standardized methods, airborne data is more local, acquired by various scanners in different conditions. Therefore, it is often necessary to seek our own methodology of data acquisition and data processing, especially in the evaluation of newly observed phenomena.

How do you actually acquire airborne data? Does your institute have a plane?

So far we have sensed our data in cooperation with professional companies that own an aircraft themselves. As we are economically quite an unattractive partner for such companies – we sense relatively small areas and research projects do not often provide enough money – we often do not have a plane available when we need it most. If we add the weather factor to it – we need a cloudless day because of the quality of data, airborne sensing can be postponed even by several weeks. Such situations could potentially lead to a failure in meeting the project objectives.

Therefore, the completion of the so-called „airborne laboratory" has become an important part of the CzechGlobe infrastructure. The laboratory

is going to include an airborne carrier Cessna Grand Caravan, which we have purchased this year, and a unique set of hyperspectral scanners covering the range from the visible to the thermal part of the spectrum. In addition, in collaboration with the infrastructure of AdMaS VUT Brno, we will be able to add more information about the space, acquired from LiDAR data, to the spectral information from HS scanners. Synergistic use of data develops a great potential for new methodological approaches in the evaluation of ecosystems. For example, we can enrich the areal map of the „health condition" of the stand with the height and shape of objects – trees, creating a 3D model of the stand and we will be able to estimate the aboveground biomass of trees and their properties.

Private aircraft available at any time, unique scanners, that all sounds interesting. However, do you think you will be able to exploit the full capacity of these devices?

I believe so. And we won't have to do it on our own. Today's scientific research is not a local issue, but cooperation by means of projects. In terms of joint projects, we do not only search for partners based on their scientific profile, but also based on their „dowry", which they would be able to enrich the project with, such as their equipment, existing data, experience, etc.

The airborne laboratory and a quality scientific team will enable us to apply for participation in major European projects, such as ESA (European Space Agency). Currently, we are partners of FLEX project, which represents a preparatory phase of ESA mission, which is focused on the possibility of assessing vegetation fluorescence signal using image sensors placed on airborne and later on satellite carriers as well. The signal sensed is supposed to contribute to more accurate estimates of gross primary production of ecosystems.

Another great potential for the device utilization that I envision is within the scope of national environment, not only for research but also for application, for example in forestry, precision agriculture, nature protection. However, it is necessary to introduce the specialists of different expertise to the possibilities that both the remote sensing as well as our laboratory can provide their field with, and at the same time to listen to their demands. We started this journey by means of the HyDaP project (OPEC), which includes 7 Czech partners, including universities and private companies. In addition, the project involves six prestigious foreign universities, whose experts will lead workshops focused on the evaluation of data types that we will be able to capture using our devices. The project also involves study visits of our staff in these foreign institutions and the preparation of joint projects.

Part of our education is also a map server *http://mapserver.czechglobe.cz* that provides an overview of the data acquired by our group, and under an agreement, it will be available to other users as well.

For CzechGlobe Newsletter
Bohumi Křivda

DEPARTMENT OF REMOTE SENSING

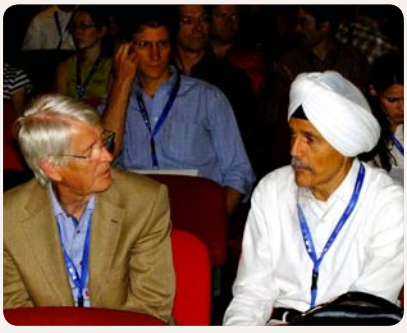
The Department of Remote Sensing is incorporated into the Division of Systems Analyses and has been developing its current focus since 2006. There are eight people to the group, including 1 researcher, 1 junior and 6 workers working as PhD students or technicians. The department is focused on the evaluation of selected types of ecosystems at different spatial and temporal scales. To solve research tasks, the department uses available time series of satellite data and current airborne data scanned for the given purpose using its own hyperspectral and thermal sensor. Special emphasis is placed on the creation of methodologies of quantitative assessment of biochemical parameters of vegetation (e.g. forest stands, agricultural crops, etc.) based on the development of imaging spectroscopy methods. A new challenge associated with the development of CzechGlobe infrastructure is a fusion of airborne hyperspectral, LiDAR and thermal data in physically based models of radiation transfer through vegetation. Products coming from LiDAR data refine the structural parametrization of models. Sensing a broader range of electromagnetic radiation will contribute to the evaluation and simulation of a wider range of quantitative characteristics of stands and their changes over time. These detailed spatial and spectral characteristics will allow the interconnection of information on the stand with information from plant physiologists on the functioning of individual trees. Temporal changes of these parameters can then uncover the links to changing habitat/climatic conditions.

The above mentioned issues are addressed within various projects supported by the National Agency for Agricultural Research, Ministry of Education, Youth and Sports (OPEC, COST) and the European Union through the 7th Framework Programme.

3RD ANNUAL CONFERENCE OF CZECHGLOBE

From 22nd to 24th May 2013, already the third annual conference of the CzechGlobe Centre was held in the Conference Centre of Myslivna Hotel in Brno. It was entitled „**Global Change and Resilience**". This year's conference was held under the auspices of the project of the Operational Programme Education for Competitiveness called „Partnership in Climate Research and Adaptation Strategies".

From the topical point of view, the conference, which was attended by 140 Czech and foreign participants, represented a cross-thematic range of topics across the research activities of the entire Centre. The speakers, who either work at the Centre or closely cooperate with it, presented their lectures within 5 sections focusing on the human dimension of the global change, climate analyses and modeling, ecosystem analyses, impact studies or physiological



analyses and adaptation and innovation techniques.

The conference also included a poster section which was primarily intended for young scientist and Ph.D. students to present their results. The best posters were selected and their authors were given a financial reward.

GOT OUR ATTENTION

WARMING IN THE ARCTIC ACCENTUATES „PLANETARY WAVES“ AND THE OCCURRENCE OF EXTREME WEATHER EVENTS

Vladimir Petoukhov, Stefan Rahmstorf, Stefan Petri, Hans Joachim Schellnhuber, *PNAS*, *April 2013*

The Arctic region is warming 2–3 times faster than the adjacent areas in the temperate zone. This effect, known as the „polar amplification“, is primarily caused by the decrease in snow and ice with high reflectivity and their substitution with a significantly lower surface albedo. This results in reducing the temperature gradient between the polar region and the temperate zone, which is the driving force of the so-called westerly winds (known as jet-stream) and it largely determines its position and stability. The authors in their work suggest a physical explanation of „persistent“ (blocking) pressure formations, related to the changes in the jet-stream. These formations have been occurring during the last 10 years significantly more often than during the last 30 years. The results obtained are other results that are strengthening the evidence that quicker warming in the Arctic increases the probability of occurrence of extreme weather events, such as the floods in Europe in 2002, followed by an extensive drought a year later, extreme heat wave in Russia, record-breaking flooding in Pakistan in 2010, a record-breaking warm spring in the USA in 2012 and finally this June's floods in Europe.

As a result of deceleration of westerly winds, we can observe a more frequent „meridional“ flow pattern in the atmosphere with more distinct amplitude, as opposed to less wavy „zonal“ flow (see Fig.). This means that the given character of the weather tends to be prolonged and is also connected with the penetration of colder air to the south and vice versa, with the penetration of warmer air to the north. Thus, we will more often encounter situations when, e.g. at the end of May this year, Finland experienced record-making temperatures around 30°C, while at the same time in the Czech Republic the temperatures were around 15°C with persistent rains.

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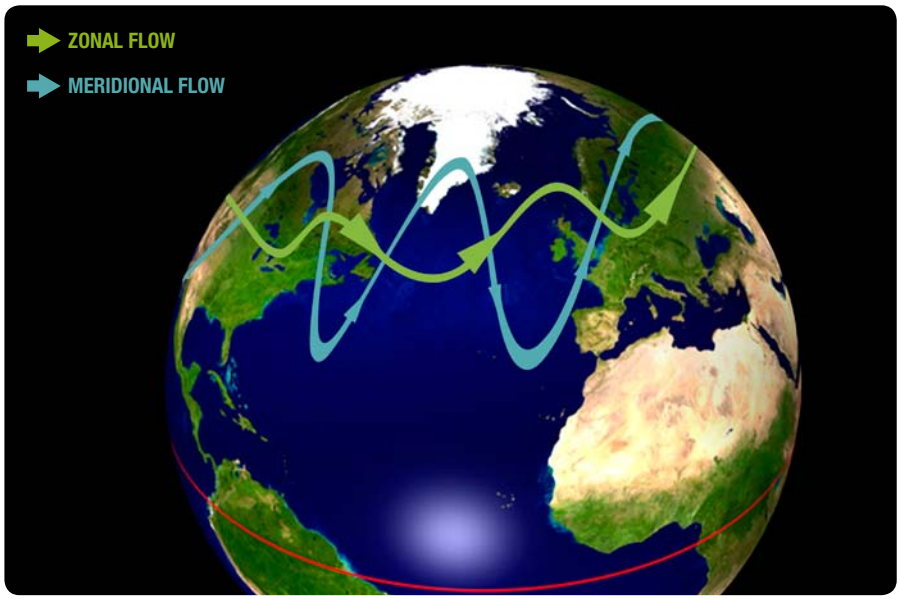
Quotation: *http://www.pnas.org/content/early/2013/02/28/1222000110*
http://www.sciencemag.org/content/early/2013/05/22/science.1233137



Schematic representation of the so-called „jet-stream“. This western flow on a boundary of arctic and mild belt air masses proceeds in the so-called Rossby waves. Different warming speed of the lower atmosphere layers affects the nature of these „planetary waves“ – as they were called by the authors of the publication in the PNAS journal. Faster progression of these waves causes zonal type of flow, and conversely, slower progression of the waves often brings meridional flow, which is often linked with extreme sort of weather. (Source: *Skeptical Science*)

WHAT'S NEW

2nd Annual Conference of COST Action FA0906 „UV4Growth“

From 14th to 16th April 2013, the Global Change Research Centre ASCR organized the 2nd annual conference within the scope of COST Action FA0906 „UV4Growth“ in Mikulov. The conference, which was focused on the presentation of research results on the effect of UV radiation on plant physiology, was attended by a hundred of experts from all over Europe as well as from the USA and New Zealand.

Annual Meeting of the Scientific Board of the CzechGlobe Center

From 20th to 22nd May 2013, the Annual Meeting of the International Scientific Board of the CzechGlobe Centre was held. The Scientific Board consisting of leading experts from universities and scientific centers around Europe and the United States evaluated scientific activities of the Centre within the past year. The final assessment says that the professional activities of the Centre are developing dynamically, the recently built infrastructure is used effectively and is just heading towards obtaining first class findings of international importance. The Scientific Board also recommended a more intense interconnection of individual teams of the Center, expansion of international cooperation as well as more active engagement of doctoral students in scientific work.

Joint workshop of ClimMani and INTERFACE networks

From 4th to 7th June 2013, the GCRC organized a joint workshop of the European Network ClimMani and American network INTERFACE in Mikulov. Both networks bring together scientists engaged in experiments and creation of models in the field of climate change impact on terrestrial ecosystems. The workshop also included an excursion to the Experimental station of Plant Ecophysiology in Domanínek, where a whole new cluster of 24 growth chambers was introduced – it will be used in controlled multi-factor experiments.

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