2016

ABSTRACT BOOK

SECOND PANNEX WORKSHOP ON THE CLIMATE SYSTEM OF THE PANNONIAN BASIN

BUDAPEST, HUNGARY, 1-3 JUNE 2016

Organized by the Hungarian Meteorological Service (OMSZ)
Supported by OMSZ and GEWEX

2nd PannEx Workshop on the climate system of the Pannonian basin
Budapest, Hungary 1- 3 June 2016

Edited by

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TABLE OF CONTENTS

2ND PANNEX WORKSHOP PROGRAMME

Budapest, Hungary
1-3 June 2016

Venue:

The Headquarters of the Hungarian Meteorological Service
(H-1024 Budapest, Kitaibel Pál str. 1.)

WEDNESDAY, 1 JUNE 2016

9:00 – 9:30 Registration

9.30-10.30 Openings, WMO talks, introductory

Boram Lee: WCRP and it's general framework on Grand Challenges.

Joan Cuxart: A Regional Hydroclimate project within GEWEX: what for?

Monika Lakatos: PannEx-Towards a Regional Hydroclimate Project in the Pannonian Basin

Jose Camacho: WMO AgM: WMO activities to support drought monitoring and drought management in South Eastern Europe

10.30-11.00 Coffee Break

11.00-12.30 Chair: Danijel Jug

Danijel Jug, Márta Birkás, Irena Jug, Vesna Vukadinović, Boris Đurđević, Bojana Brozović, Bojan Stipešević: Agriculture in the Pannonian Basin facing new challenges related to climatic change

Angéla Anda and Gábor Soós: Estimation of regional evapotranspiration from a wetland in Hungary

Péter Molnár and Gábor Kolossváry: Water management and irrigation in Hungary

Irena Jug, Danijel Jug, Vesna Vukadinović, Boris Đurđević, Bojana Brozović, Bojan Stipešević, Marijana Tucak: Effects of climate change on crop production

Nándor Fodor, László Pásztor, Zsófia Bakacsi, Ferenc Horváth, Bálint Czúcz, Anikó Zölei, Gábor Illés, Zoltán Somogyi, András Molnár, József Szabó, Sándor Koós: AGRAGiS: Assessing the vulnerability of the Hungarian agriculture under changing climatic conditions

12.30-14.00 Lunch break

14.00-15.30 Chair: Tamás Weidinger

Helga Tóth, Balázs Szintai and László Kullmann: Biomass and Soil Moisture simulation and assimilation in Hungary in the framework of IMAGINES project

Mirjana Brmez, Josipa Puskaric, Emilija Raspudic: Nematode community structure in soil as bioindicator of climate change

DOI: 10.21404/PANNEX.2016

Dejan Stojanovic: Impact of Drought on Forests: Correlation between Oak Growth and Drought Indices

Imelda Somodi, Ákos Bede-Fazekas, Nikolett Lepesi, Bálint Czúcz: Potential Impact of climate change on natural habitats in Hungary

Željko Večenaj and Branko Grisogono: Micrometeorological research at the Department of Geophysics, University of Zagreb

15.30-16.00 Coffee break

16.00-17.00 Poster session

17.00-18.00 IPC meeting, WB drafting, discussions on topics touched during the day with participation of IPC members and chairs and rapporteurs of the day

End of the day

THURSDAY, 2 JUNE 2016

9.00-10.30: Chair: Joan Cuxart

Conclusion of the day before: reports of chairs and rapporteurs

Branka Ivancan-Picek: HyMeX – from the science plan to implementation plan

Tamás Mona, Ferenc Ács, Hajnalka Breuer: Investigation of weather-PBL height diurnal course relationships in the Pannonian Plain during summer periods

Imre Salma, Zoltán Németh, Tamás Weidinger, Ágnes Molnár, Kornélia Imre: Atmospheric nucleation and its relevance in the Carpatian Basin

Zita Ferenczi and Kornélia Imre: Overview of the (ground-level) ozone problem: formation, measurements, trends and impacts (Hungarian specialties)

Sonja Vidič, Ivona Igrec, Vedrana Džaja Grgičin: Precipitation chemistry trends in Croatian part of the Danube region

10.30-11.00 Coffee break

11.00-12.30 Chair: Vladimir Djurdjevic

Sorin Cheval, Dan Constantinescu, Alexandru Dumitrescu: Monitoring the urban heat island and its impact on the indoor thermal risk in Bucharest (Romania)

Dóra Lázár and Tamás Weidinger: Adaptation and sensitivity study of CMAQ–SMOKE–WRF air quality model system for ozone precursor emissions
in Carpathian Basin

Dávid Tátrai, Joan Cuxart, Tamas Weidinger, Andrea Kircsi, János Józsa, Melinda Kiss: Infrasound measurements for the detection of local and remote turbulence

forward to FQ4 issues Chair: Monika Lakatos

Gregor Gregorič and Andreja Sušnik: Drought monitoring in Slovenia and SE Europe - status and plans for the future

Márton Jolánkai, Márta Birkás, Katalin M. Kassai, Ákos Tarnawa: Crop production adaptation to climate change

Sándor Szalai: Hydrometeorological forecasting and early warning systems

12.30-14.00 Lunch break

14.00-15.30 Chair: Adina-Eliza Croitoru

Zita Bihari, Tamás Szentimrey, Mónika Lakatos, Sándor Szalai: DanubeClim - An extension of the CarpatClim project

Amanda Imola Szabó, Ferenc Ács, Hajnalka Breuer: Climate of the Carpathian Basin according to Feddema using the CarpatClim dataset

Svitlana Krakovska, Tetyana Shpytal, Oleg Skrynyk, Lyudmyla Palamarchuk: Some temperature indices under current and projected climate change conditions in the Transcarpathian lowland of Ukraine

Gabriella Szépszó: Uncertainty and value of precipitation projections for the Carpathian Basin

Judit Bartholy, Rita Pongrácz, Hajnalka Breuer: Possible contribution ideas to a complex Pannonian study

Adina-Eliza Croitoru*:* Education, knowledge transfer and outreach

15.30-16.00 Coffee break

16.00-17.00 IPC meeting, WB drafting, discussions on topics touched during the day with participation of IPC members and chairs and rapporteurs of the day

18.00-21.00 Social event

End of the day

FRIDAY, 3 JUNE 2016

9.00-10.30 Chair: Branka Ivančan-Picek

Conclusion of the day before: reports of chairs and rapporteurs

White book drafting

10.30-11.00 Coffee break

11.00-12.30 Chair: Mónika Lakatos

Continuation of White book drafting

12.30 Closing

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LIST OF PRESENTATIONS

Boram Lee: WCRP and it's general framework on Grand Challenges

Joan Cuxart: A Regional Hydroclimate project within GEWEX: what for?

Monika Lakatos: PannEx-Towards a Regional Hydroclimate Project in the Pannonian Basin

Jose Camacho: WMO AgM: WMO activities to support drought monitoring and drought management in South Eastern Europe

Danijel Jug, Márta Birkás, Irena Jug, Vesna Vukadinović, Boris Đurđević, Bojana Brozović, Bojan Stipešević: Agriculture in the Pannonian Basin facing new challenges related to climatic change

Angéla Anda and Gábor Soós: Estimation of regional evapotranspiration from a wetland in Hungary

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Nándor Fodor, László Pásztor, Zsófia Bakacsi, Ferenc Horváth, Bálint Czúcz, Anikó Zölei, Gábor Illés, Zoltán Somogyi, András Molnár, József Szabó, Sándor Koós: AGRAGiS: Assessing the vulnerability of the Hungarian agriculture under changing climatic conditions

Helga Tóth, Balázs Szintai and László Kullmann: Biomass and Soil Moisture simulation and assimilation in Hungary in the framework of IMAGINES project

Mirjana Brmez, Josipa Puskaric, Emilija Raspudic: Nematode community structure in soil as bioindicator of climate change

Dejan Stojanovic: Impact of Drought on Forests: Correlation between Oak Growth and Drought Indices

Imelda Somodi, Ákos Bede-Fazekas, Nikolett Lepesi, Bálint Czúcz: Potential Impact of climate change on natural habitats in Hungary

Željko Večenaj and Branko Grisogono: Micrometeorological research at the Department of Geophysics, University of Zagreb

Branka Ivancan-Picek: HyMeX – from the science plan to implementation plan

Tamás Mona, Ferenc Ács, Hajnalka Breuer: Investigation of weather-PBL height diurnal course relationships in the Pannonian Plain during summer periods

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Sonja Vidič, Ivona Igrec, Vedrana Džaja Grgičin: Precipitation chemistry trends in Croatian part of the Danube region

Sorin Cheval, Dan Constantinescu, Alexandru Dumitrescu: Monitoring the urban heat island and its impact on the indoor thermal risk in Bucharest (Romania)

Dóra Lázár and Tamás Weidinger: Adaptation and sensitivity study of CMAQ–SMOKE–WRF air quality model system for ozone precursor emissions in Carpathian Basin

Dávid Tátrai, Joan Cuxart, Tamas Weidinger, Andrea Kircsi, János Józsa, Melinda Kiss: Infrasound measurements for the detection of local and remote turbulence

Gregor Gregorič and Andreja Sušnik: Drought monitoring in Slovenia and SE Europe - status and plans for the future

Márton Jolánkai, Márta Birkás, Katalin M. Kassai, Ákos Tarnawa: Crop production adaptation to climate change

Sándor Szalai: Hydrometeorological foreasting and early warning systems

Zita Bihari, Tamás Szentimrey, Mónika Lakatos, Sándor Szalai: DanubeClim - An extension of the CarpatClim project

Amanda Imola Szabó, Ferenc Ács, Hajnalka Breuer: Climate of the Carpathian Basin according to Feddema using the CarpatClim dataset

Svitlana Krakovska, Tetyana Shpytal, Oleg Skrynyk, Lyudmyla Palamarchuk: Some temperature indices under current and projected climate change conditions in the Transcarpathian lowland of Ukraine

Gabriella Szépszó: Uncertainty and value of precipitation projections for the Carpathian Basin

Judit Bartholy, Rita Pongrácz, Hajnalka Breuer: Possible contribution ideas to a complex Pannonian study

Adina-Eliza Croitoru: Education, knowledge transfer and outreach

LIST OF POSTERS

Judit Gerhátné Kerényi and Ildikó Gróbné Szenyán: Climate and drought monitoring using satellite data

Zoltán Bozóki, Dávid Tátrai, Gábor Szabó: Dual channel photoacoustic hygrometer for airborne measurement of cloud water/ice content

Daniel Muange Mbithi, Ermias Demessie, Tendai Kashiri: The impact of land use and land cover changes on land surface temperature of Addis Ababa City, Ethiopia

Joan Cuxart, Blazenka Matjacic: Mesoscale circulations under high-pressure conditions in the Pannonian Basin

Bojana Brozović, Danijel Jug, Bojan Stipešević, Irena Jug, Vesna Vukadinović, Boris Đurđević: Climate changes and weeds

Boris Đurđević, Irena Jug, Vesna Vukadinović, Danijel Jug, Srđan Šeremešić, Bojana Brozović, Bojan Stipešević: Can Biochar mitigate climate changes?

Inna Semenova: Assessment of warm seasonal droughts in Transcarpathia under past and future climate conditions

Valeriya Ovcharuk, Inna Semenova: Modern hydroclimatic condition of forming minimum runoff Transcarpathian rivers and possibility it modeling

Vesna Vukadinović, Danijel Jug, Irena Jug, Boris Đurđević, Bojana Brozović, Bojan Stipešević: Effect of climate on some soil properties and crop production

Branko Grisogono, Željko Večenaj, Andreina Belušić, Kristina Šarović, Stjepana Brzaj, Irena Nimac, Jurica Suhin, Vinko Šoljan, Martin Belavić: Microscale properties of bora turbulence at the new micrometeorological research facility

Tamas Weidinger, Joan Cuxart, András Zénó Gyöngyösi, Gyula Horváth, Zoltán Istenes, Zoltán Nagy, Péter Salavecz, Gemma Simó, Dávid Tátrai, Ágoston Tordai, Csaba Torma, Burkhard Wrenger: PABLS'15 Planetary Boundary Layer Measurement Campaign, Szeged

Andreina Belušić, Maja Telišman Prtenjak, Ivan Güttler: Near-surface wind patterns obtained by regional climate simulations for south-eastern Europe

Valeriya Ovcharuk, E.Gopchenko, M.Goptsy: Method of determining the maximum flood runoff for ungauged rivers of the Ukrainian Carpathians

Zoltán Varga, Zoltán Varga-Haszonits: Analysis of relationship between drought and cultivation of field crops in the Pannonian Basin

Mary - Jeanne Adler, Silvia Chelcea, Mihai Retegan: Climate Change Impact in some of the Romanian Pilot Basins

Liliana Zaharia, Adina Eliza Crioitoru, Nicoleta Ionac, Ionuţ Minea: Geographical higher education in Romania and its contribution in hydro-meteorological training. Current status and future challenges

Marijana Tucak, Danijel Jug, Irena Jug, Tihomir Cupic, Svetislav Popovic: Contribution of plant breeding in mitigating climate change

Karolina Vrandecic, Jasenka Cosic, Jelena Ilic: Influence of climate changes on plant diseases in Croatia

Andrej Ceglar, Stefan Niemeyer: Agricultural production in south-eastern Europe in changing climate conditions

Vira Balabukh: Climate Change and Extreme Weather Events in the Transcarpathian area of Ukraine

Mónika Lakatos, Lilla Hoffmann: Heavy rainfall – methodology to estimate the IDF curves for Hungary

Anna Zsilinszki, Zsuzsanna Dezsõ, Judit Bartholy, Rita Pongrácz, Erzsébet Kristóf: The changing role of the polar jet in regional weather conditions in the Pannonian region

Anna Kis, Rita Pongrácz, Judit Bartholy, János Adolf Szabó: The estimations of extreme runoff characteristics by RegCM driven hydrological model

Júlia Göndöcs, Hajnalka Breuer, Rita Pongrácz, Judit Bartholy: Studying the effect of urban environment during heat waves with the WRF model - A Budapest case study

Karolina Szabóné André, Judit Bartholy, Rita Pongrácz: Analysis of presistent cold air pools over the Pannonian basin

Dumitrescu Alexandru, Aristita Busuioc: Assessing the potential of EURO-CORDEX regional climate models in reproducing extreme precipitation over Romania

Marius-Victor Birsan, Roxana Bojariu, Alexandru Dumitrescu, Sorin Ionut Dascalu, Madalina Gothard, Roxana Cica: Local climate responses in the Danube river basin under global warming

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ABSTRACTS

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WCRP AND IT'S GENERAL FRAMEWORK ON GRAND CHALLENGES

Boram Lee

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The World Climate Research Programme (WCRP), sponsored by the World Meteorological Organization (WMO), the International Council for Science (ICSU), and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, has the major objectives to determine the predictability of climate and the effects of human activities on climate. It furthermore endeavours that the WCRP sponsors and nations around the world have the most up-to-date tools, methods and information necessary to meet their climate-related mandates that benefit to society.

Building upon the global efforts of the climate research community, WCRP coordinates a range of activities from observations to modelling, on a foundation of Core-Projects: These are international programs facilitating research, observations, and science activities relating to the relationship between elements of the Earth's physical climate system – atmosphere, oceans, sea and land ice, and the land surface:

- CliC (Climate and Cryosphere): improving understanding of the cryosphere and its interactions with the global climate system;
- CLIVAR (Climate and Ocean: Variability, Predictability and Change): understanding the dynamics, interaction, and predictability of the coupled ocean-atmosphere system;
- GEWEX (Global Energy and Water cycle Exchanges): observing, understanding, and modelling the hydrological cycle and energy fluxes on the Earth's atmosphere and surface;
- SPARC (Stratosphere-troposphere Processes And their Role in Climate): promoting and facilitating international research activities on how chemical and physical processes in the atmosphere interact with a changing climate; and,
- CORDEX (Coordinated Regional Climate Downscaling Experiment): coordinating the science and application of regional climate downscaling through global partnerships to better understand regional climate phenomena, their variability and changes.

WCRP recognizes areas of major challenges in climate research, either due to lack of data, gaps in scientific understanding or technological constraints. In response, it has undergone refreshment and refocusing at several levels through an extensive community engagement process. In doing so, a few Grand science Challenges (GCs) have been identified, which focus on areas of high-priority research that require international partnerships and coordination on a foundation of the Core-Projects, and that yield actionable information for decision makers:

- Cloud, circulation and climate sensitivity;
- Melting ice and global consequences;
- Understanding and predicting weather and climate extremes;
- Regional sea level change and coastal impacts; and,
- Water for the food baskets of the world.

DOI: 10.21404/PANNEX.2016

In addition, two new GCs are recently adopted: These focus on climate-carbon interactions, and on climate prediction on time scales from years to decades. WCRP promotes these GCs through community-organized workshops, conferences and strategic planning meetings as well as to advocate further for international partnership and coordination. In addition to these new foci, an emphasis is placed for more efficient coordination and promote for regional climate research activities, in support of providing climate information required to develop policies, to assess impacts and risks, and to plan adaptation measures. Urban climate issues, particularly in coastal cities, are highlighted in this context, to improve provision of reliable climate information and interconnection with urban stakeholders.

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A REGIONAL HYDROCLIMATE PROJECT WITHIN GEWEX: WHAT FOR?

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The GEWEX structure and its Grand Challenges will be described, as well as the currently running RHPs and cross-cut projects. The different approximations to an RHP will be discussed. A reflexion will be made on how Pannex would fit into the RHP scheme, including the potential benefits and the requests to be fulfilled, for the purpose of further discussion among participants.

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PANNEX-TOWARDS A REGIONAL HYDROCLIMATE PROJECT IN THE PANNONIAN BASIN

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The climate of the Carpathian Region - Pannonian basin in the depth is affected by the oceanic, Mediterranean and continental climate types. The latitudes and orography modify the macroclimatic features. Individual characteristics of the region are determined by the chain of Carpaths, which surround the basin, only the southern part is flat terrain. Therefore, the different climate influences can be modified by the Carpaths. They are relatively low and long mountains, but are able to redirect air masses giving the region special climate, differing from the neighbouring areas.

PannEx is a prospective Regional Hydroclimate Project (RHP) of the World Climate Research Programme (WCRP) Global Energy and Water Exchanges Project (GEWEX). The almost closed structure of the Pannonian basin makes it a unique natural laboratory for the study of the water and energy cycles, focusing on the physical processes of relevance.

The GEWEX-promoted workshop on the Climate System of the Pannonian Basin took place at the Faculty of Agriculture of the University of Osijek, Croatia, 9-11 Nov 2015. Final conclusion of this workshop was that the community has the necessary size, scientific level and will to undertake a supranational action at the scale of the Pannonian Basin. This action may be organized as a Regional Hydroclimate Project (RHP) under the umbrella of the GEWEX Hydroclimatological Panel. This initiative, with the acronym "PannEx", was seen as a good opportunity to foster cooperation between the different institutions and exchange of data, knowledge and expertise between partners, as well as a platform to obtain funding for the related activities.

A PannEx White Book is under preparation that develops the ideas expressed in the first workshop. A first draft of this PWB will be discussed in the second meeting. It will outline the main science issues on the Pannonian basin. The 2nd workshop results will allow to refine the content of the PWB and provide details of each specific flagship questions and cross cutting issues. Also, the Budapest workshop will provide a good opportunity to create partnerships in the region and increase the visibility of the PannEx initiative.

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WMO AGM: WMO ACTIVITIES TO SUPPORT DROUGHT MONITORING AND DROUGHT MANAGEMENT IN SOUTH EASTERN EUROPE

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WMO is a specialized agency of the United Nations (UN). It is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces and the resulting distribution of water resources. WMO Technical commissions are responsible for studying meteorological and hydrological operational systems, applications and research. The Commission for Agricultural Meteorology (CAgM) is to provide guidance in the field of agricultural meteorology by studying and reviewing the available science and technology. Regional Offices coordinate with the various departments at WMO headquarters that work in the area of Capacity Development to implement resource mobilization, partnership building and advocacy-related activities in their region. South Eastern Europe belongs to WMO Region VI.

In early 2009, the European Commission, Directorate General Enlargement (EC DG Enlargement) , concluded agreement with the WMO for the implementation of the action entitled: "Disaster Risk Reduction in South East Europe - Activity 2: Regional cooperation in South East Europe for meteorological, hydrological and climate data management and exchange to support disaster risk reduction". The same EC DG Enlargement approved in 2012 the IPA/2012/290-552 Project: “Building resilience to disasters in Western Balkans and Turkey” for joint implementation by the UNISDR (leading agency) and the WMO. This project was built upon the results of previous IPA/2009 Project.

The Drought Management Centre for South-Eastern Europe (DMCSEE, www.dmcsee.org), which is based at the Environmental Agency in Slovenia was founded in 2006 with the support of the WMO and the United Nations Convention to Combat Desertification (UNCCD). Its mission is to support the 13 participating countries to improve drought monitoring activities, develop a coordinated approach for drought impact assessment and help the countries into response, prevention and recovery plans.

To achieve the development and implementation of National Drought Policies in the region, WMO in coordination with other UN Agencies held a High Level Meeting on the Development of National Drought Policies where the Integrated Drought Management Programme (IDMP) was born in March 2013. As one of the first outcomes, a IDPM regional project funded by GWP was developed from 2013 to 2015 in 10 countries from Central and Eastern European countries. IDMP project received assistance through the IDMP Technical Support Unit based at WMO Headquarters. The project covered various aspects of drought management such as water, agriculture, forestry and meteorology.

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Other sub-regional organization of interest is the South East European Virtual Climate Change Center (SEEVCCC) hosted by Republic Hydrometeorological Service of Serbia. SEEVCCC is an official member of the RA VI Regional Climate Center-Network, and is operational since 2009. Providing operational Long Range Forecasts for broader Southeastern Europe this center may support drought monitoring and management activities. Finally, WMO has performed 14 editions of the South Eastern Europe Regional Climate Outlook Forum (SEECOF) to provide guidance on the expected characteristics of the winter rainy season for that region. Winter has been selected because rains are more relevant for crops and water resources management.

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AGRICULTURE IN THE PANNONIAN BASIN FACING NEW CHALLENGES RELATED TO CLIMATIC CHANGE

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The Pannonian basin and the peri-Pannonian region are faced with changing climatic conditions and consequences already felt all over the region. Agriculture suffers from changing climatic elements, such as precipitation, temperature, weather extremes and evaporation rates, which impact production in direct and many indirect ways. Many techniques and technologies are offered as an adequate solution for adaptation and mitigation to climate change, but some of these really function. Conservation agriculture (CA) is one of the possible ways to combat primarily negative influence of climatic changes. CA includes three main bases for successful agriculture production in relation to agro-ecological conditions, namely: minimal set of soil tillage treatments (minimal soil disturbance), permanent soil cover (with crop or crop residue) and diversification in crop production (predominantly crop rotation). The applications of these principles will positively affect many others key elements of crop production (plant nutrition, soil matters, irrigation, plant breeding, crop protection, environmental considerations, etc.). Since the soil is still the basic media for crop production, soil tillage can play a major role in soil vulnerability to climatic change. Soil tillage affects many soil quality aspects: erosion (by water and wind), biogenity (organisms), organic matter, water content (storage, infiltration), compaction (anthropogenic or natural causes), nutrient status, pest and diseases (potential risk), weed infestation, in word physical, chemical and biological aspects. As soil tillage is closer to CA principles, we can expect less damages and potential problems and risks. At this moment, the application of CA in the Pannonian Basin is still very heterogeneous and persists on different levels and with different success in every country of the region. Since climatic changes do not follow national borders and since agriculture is extremely vulnerable to them, a common action to find adequate and effective measures to face climatic changes is an imperative. For successful approach to adaptation and mitigation processes, we need to create an adequate and useful information system (mainly about usually applied technology in crop production and agro-ecological conditions), which will be used as a starting point in processes of creating strategy and decision making. The adaptation and mitigation of climatic change needs to be based on long-term research and in relation with stronger regional cooperation with professional competence to reach the satisfying results in relation to agro-ecological conditions-crop production-environment.

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ESTIMATION OF REGIONAL EVAPOTRANSPIRATION FROM A WETLAND IN HUNGARY

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Pragmites australis evapotranspiration (as measured by an evapotranspirometer, or ET) was detected at the Keszthely Agrometeorological Research Station between 2005 and 2011, except for 2007 (due to financial and technical restrictions). Multiple regression analysis and Akaike Information Criterion were used to determine the relationship between ET and different meteorological variables, and indicated that the leading factors were the air temperatures and net radiation on ET during the six-season study. In the common reed community, the driving force on ET was the available energy. Of the six seasons investigated, one normal, one cool and four hot seasons could be distinguished. In the first step, variation in the crop coefficient (Kc) of local common reed (Phragmites australis) stands based on ET and local reference (Penman-Monteith) ETo measurements at the surroundings of Lake Balaton, Hungary was analysed. ET was measured daily over several seasons with modified Thornthwaite-Matter evapotranspirometers with compensative irrigation using free-flowing above-ground water that enabled the long-term cultivation of common reed. ET of common reed averaged 779 mm for the six-season study period while the mean Kc value was 1.23. Seasonal mean Kc values for common reed ranged from 0.73 to 1.37 irrespective to weather conditions. In cool weather (seasonal mean air temperatures < 17°C), annual mean Kc and ET were 0.73 and 385 mm, respectively while in hot weather (seasonal mean temperatures above 18°C), Kc and ET were 1.37 and 875.4 mm, respectively. During the six-season observation, the high monthly differences in Kc obtained indicated that consistent Kc throughout the season was not appropriate for determining common reed ET. A monthly time scale and weather conditions – also LAI in hot summers – should be considered parameters to improve the accuracy of common reed ET estimation. In addition to the dominant common reed (Phragmites australis), the cover ratio of the other four plant groups [cattail (Typha angustifolia, Typha latifolia); sedge (Carex acutiformis, Carex elata, Carex riparia); shrubs (Salix cinerea, Salix alba); tree patches (Salix fragilis, Alnus glutinosa, Populus tremula) and grassland (Festuca rupicola, Arrhenatherum elatior, Alopecurus pratensis)] and open water were monitored. The different cover categories of the wetland were separated using images with surface interpretation using the maximum likelihood classification method. Regional ET for our sample area of Fenéki "Pond" (FP, Kis-Balaton Wetland) was estimated using weighted canopy areas of above five macrophyte classes and open water over between 1997 and 2012 (uninterrupted period without any human intervention). This observation highlights that the use of a weighted canopy cover method can provide valid information for estimating ET for the FP wetland. The largest water consumer, common reed, surpassed the long-term annual average ET rate for the FP wetland by 8.9%. Two crucial water consumers, common reed and sedge, contributed to half and a third of total ET loss, respectively. Beyond the different applied methods, the neglect of macrophyte composition can also be a potential source of error in a wetland's ET approach. In this study, if only common reed was considered, the error would be an 11.6% overestimation of ET. However, in addition to common reed, had only sedge been included, this would have almost halved the estimation error to 6%. The projected monthly ET values produced by seasonal ARIMA (1,0,0)(0,1,1)12 model maintained an earlier observed seasonal pattern due to wetland peculiarities.

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WATER MANAGEMENT AND IRRIGATION IN HUNGARY

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In the first part of my presentation I would like to give a short overview of the Water Framework Directive and the related Hungarian River Basin Management Planning process. To assess Hungary's water management it is necessary to have a look at the country's water balance and describe our surface and groundwater resources. With regards to water utilization, especially irrigation I would like to show the results and main tasks of the Irrigation Department of the General Directorate of Water Management. These contain among others the maintenance and upgrading of water supply systems, promotion of water saving technologies in irrigation, identification of irrigation plots, the results of our water demand survey conducted recently. Speaking about new developments it is also worth to mention the irrigation information system, EU financed irrigation related projects, a planned study on water reuse and the development of an operational drought monitoring system. Finally I would like to emphasize the importance of water retention and storage as one of our department's priorities.

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EFFECTS OF CLIMATE CHANGE ON CROP PRODUCTION

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In modern agriculture, abiotic stresses are probably the biggest constraints factor of food production. Agriculture is affected by climate changes, but it also contributes to approximately 25% of the greenhouse gases emissions. The effects of climate change on crop production will depend on the current climate and soil conditions, the direction of change and the availability of natural resources. Plants respond to climate change with morphological and/or physiological adaptations. Tolerance of plants to extreme conditions of the external environment is supported by very complex biochemical - physiological mechanisms that regulate probably several hundred genes through the appropriate enzyme-controlled reactions. The important determinants of plant distribution depend on the temperature effects–average, minimum or maximum, rainfall and some other factors (such as soil type). The Earth is facing global warming and we can expect an increasing damage in plant production from high temperatures. The estimates of yield reduction with increasing temperature range up to 17% for every 1°C. The reduced ability of plants to disclosure of excess heat is the most common cause of heat stress and significantly affects the function of biological membranes, denaturation of proteins with increased cellular respiration. The enhanced resistance of plants to high temperatures can be achieved by using adenine, kinetin, vitamin B and Zn - complexes which affect the metabolism of nucleic acids, amino acids and proteins. The increase in global average temperatures would further result in drastic shifts in the annual precipitation with a 20% reduction per year, and about 20% loss in soil moisture. Higher atmospheric CO2 levels tend to reduce transpiration, lowering thereby the latent heat loss and causing higher leaf temperatures. The effect of the lack of water is usually observed reduced growth which is associated with a decrease rate of photosynthesis and metabolic disorders of nitrogen and carbon. The reaction of plants to drought conditions is complex, because the drought stress is usually associated with the problems of reception and transport of nutrients, which is reflected in the overall metabolism. The excess water and/or floods cause physiological disorders and damage plant roots, as incompletely oxidized metabolic products accumulate to toxic levels, and the root of these conditions can provide the plant with sufficient nutrients. The stress caused by an excess of water results in an increase in the concentration of abscisic acid (ABA) and ethylene in the waterlogged roots with slowed or retarded plant growth. Understanding how plants will respond to the rapid change in CO2 concentration, the temperature and precipitation variations with developing knowledge about their ability to adapt, is an essential initial step in understanding the full impact that the multiple interacting factors of global change will have on agroecosystems.

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AGRAGIS: ASSESSING THE VULNERABILITY OF THE HUNGARIAN AGRICULTURE UNDER CHANGING CLIMATIC CONDITIONS

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The agriculture related effects of climate change in Hungary would prospectively be mainly negative. The spectrum of mitigating factors is very wide comprising soil conservation techniques, automated precision irrigation, plant breeding and innovative ICT systems, as well. The overall objective of the National Adaptation Geo-information System (NAGiS) project is to create a multipurpose geo-information system that can support the policy-making, strategy-building and decision-making process related to the impact assessment of climate change and elaborating necessary adaptation actions for Hungary. One step forward, the main objective of the AGRAGiS project is to extend the NAGiS database within the agriculture sector (crop lands, forestry and rangeland management) by producing new, 10×10 km resolution gridded data and indicator layers covering the area of Hungary using a four-step methodology: 1) A database of the relevant data layers (climate, soil, plant) is created; 2) Static and dynamic models are combined with the latest climate change scenarios in order to calculate the potential impact of climate change on biomass production; 3) Adaptive capacity indicators are created based on nationwide databases (KSH, FADN, etc.); 4) spatially explicit vulnerability is approximated by a function of the potential impact and the adaptive capacity.

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BIOMASS AND SOIL MOISTURE SIMULATION AND ASSIMILATION IN HUNGARY IN THE FRAMEWORK OF IMAGINES PROJECT

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In the framework of ImagineS (Implementation of Multi-scale AGricultural INdicators Exploiting Sentinels) project a Land Data Assimilation System (LDAS) is applied at the Hungarian Meteorological Service (HMS) to monitor the above ground biomass, surface fluxes (carbon and water) and the associated root-zone soil moisture at the regional scale (spatial resolution of 8 km x 8 km) in quasi real time. In this system the Surfex model is used, which applies the ISBA-A-gs photosynthesis scheme to describe the evolution of vegetation. Surfex is forced using the outputs of the ALADIN numerical weather prediction model run operationally at HMS. The radiation information are coming from LandSAF satellite products. First, Surfex is run in open-loop (i.e. no assimilation) mode for period 2008-2015. Secondly the Extend Kalman Filter (EKF) method is used to assimilate LAI Spot/Vegetation (till May 2014) and PROBA-V (from June 2014) and SWI ASCAT/Metop satellite measurements. The EKF run was compared to the open-loop simulation and to observations (LAI and Soil Moisture satellite measurements) over the whole country and also to a selected site in West-Hungary (Hegyhátsál). This grassland site is operated by the Eötvös Loránd University (ELTE), which is a sub-contractor of OMSZ in the ImagineS project. In Hegyhátsál the measurements (LAI, moisture and CO2 fluxes) are made at 3 m and 82 m heights of the tower. The results are evaluated with both kinds of samples. It is shown that with data assimilation we got more realistic biomass and soil moisture analyses than with open-loop mode. On the other hand it will be shown that the above-ground biomass simulated by LDAS over wheat relates very well to agricultural yields.

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NEMATODE COMMUNITY STRUCTURE IN SOIL AS BIOINDICATOR OF CLIMATE CHANGE

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Biological component of soil is mostly present in 0-30 cm of soil layer and among other things (vegetation, soil type, management practices, etc.) strongly affected by climate change, especially extremes. Nematodes are the most dominant soil fauna, present in every part of Earth lithosphere in relatively high occurrence and diversity (Bongers & Ferris, 1999.). Nematodes are present in every soil types where they live in water film around the soil particle, and rapidly respond to changes in ecosystem caused by anthropological or environmental factor. They represent the most useful indicator in soil processes and soil health. Abundance of nematode in the soil in Croatia declined rapidly, especially in last few years. Agroecosystem in Croatia (Osijek) under soybean counted above 3000 nematodes in 100 g-1of soil in nineties (Raspudic, 1992; Raspudic et al., 1994), while Majic (2009) reported (same area) average number of nematodes in soybean 317, 204 and 323, from 2005-2007 respectively. Brmez (1999) reports total number of nematodes in poplar from 961 in year 1997 and 1056 individuals in 1998, while in recent few years' abundance barely exceeds 200 nematodes in 100 g -1 of soil in same site (unpublished data, Brmez). Great number of similar scientific papers were published where variations in nematode population has been demonstrated in relation to climatic conditions, but rarely with evidence that soil temperature and moisture were measured on the day of sampling. Without such data nematode dynamics related to soil temperature and moisture cannot be completed. In order to know how climate extremes, affect biodiversity of nematodes in soil, as a main representative of biological component of the soil, continuous monitoring is necessary for observing changes in dispersal and distribution of nematodes, both through regions and vertically in soil.

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IMPACT OF DROUGHT ON FORESTS: CORRELATION BETWEEN OAK GROWTH AND DROUGHT INDICES

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In order of achieving the goals in forestry, which usually have perspective of more than 100 years, inclusion of changing climate conditions are prerequisite. Some impacts of climate change on forests in Serbia are already noticed (increased mortality, increased frequency of forest fire events, more intensive pest attacks, etc.), but the crucial issues are expected to come. In that sense, it is important to understand what are the main drivers of forest decline and how to potentially adapat forests to those changed conditions. This research was based on climate data from CARPATCLIM database and dendrochronological samples from oak forest in Serbia. Analysed were correlations between time-series of tree-ring data and drought indices (Standardized Precipitation Index - SPI, Standardized Precipitation Evapotranspiration Index – SPEI, Reconnaissance Drought Index-RDI and Palmer Drought Severity Index – PDSI). Into consideration different periods for drought indices were taken. Indices SPEI and RDI were rarely analysed together with tree-rings before this study. Results showed that all indices were significantly correlated with oak growth for spring and summer months. Correlations between indices which take into account cumulative precipitation values (e.g. 3,6, 12 moths) were much stronger then single monthly sums of precipitation. Generally, longer drought events quantified through 12-months index values were more important than shorter seasonal droughts. Drought indices can be effectively used for explanation of forest vitality loss and growth decrease. Acknowledgments This research was conducted within the project financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia for the period 2016–2019.

POTENTIAL IMPACT OF CLIMATE CHANGE ON NATURAL HABITATS IN HUNGARY

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Hungary is at the interface of the forested and the steppe biome hosting the forest steppe biome as well. Thus the change in temperature and precipitation conditions expected due to climate change will likely greatly influence the location of border of these biomes and thus that of natural habitats belonging to these will be displaced. We identified natural habitats likely to be most sensitive to cliamte change by bioclimatic modelling based on their current distribution and the abiotic characteritics of their locations. Potential impact given two regional climate models have been estimated by applying the models for future climate conditions. Two time periods were considered: 2021-2050 and 2071-2100. Forests appearedto be heavily and negatively influenced by climate change, while some of the grasslands are likely to benefit from the changes expected. For most of the haitats patterns were consistent over climate models and periods, while inconsistencies appeard for a lowland forest and a mountain grassland type depending on the climate model and the time period investigated. We can conlcude that climate change is likely to greatly influence our landscape by differentially affecting habitats from the forest and grassland biome, shifting potential vegetation towards grasslands and therefore altering water and energy cycle driven by terrestial ecosystem.

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MICROMETEOROLOGICAL RESEARCH AT THE DEPARTMENT OF GEOPHYSICS, UNIVERSITY OF ZAGREB

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Micrometeorological studies are necessary for a complete understanding of the physical processes in the atmospheric boundary layer (ABL) as they complete information about the turbulent exchange of momentum, energy and matter between the ground (solid or liquid surfaces) and the lower troposphere. Without this information, it is impossible to qualitatively close partial differential equations that are built into mathematical models for numerical weather prediction. At the same time, micrometeorological measurements still represent a challenge in atmospheric sciences. The reason for this is primarily in the demanding characteristics of the instruments, e.g., high sampling frequency of meteorological variables,, and nontrivial performance of the measurements themselves (e.g., the data from different locations and different heights above the surface need to be synchronized). Nevertheless, since the beginning of this century, Department of Geophysics at the University of Zagreb (DGUZ) invests continuous effort and resources into micrometeorological research and already for ten years perfects itself in that direction. The main motive for entering this area was investigation of the bora turbulence about which, until then, was very little known. For this purpose, DGUZ performed micrometeorological measurements of bora wind using 3D ultrasonic anemometers in the town of Senj (2004 – 2006), in Vratnik Pass (2004 – 2005) and on the Pometeno brdo in the hinterland of the city of Split (2010 – 2011, in cooperation with the Croatian Meteorological and Hydrological Service). The interest expands in the purpose of air pollution studies, so in 2009 DGUZ carried out micrometeorological research in the town of Kutina, ~ 60 km west of Zagreb. Furthermore, in 2014, first measurements of bora wind using a hot wire anemometer were conducted. The need for micrometeorological research becomes greater every day in economy sectors such as traffic, agriculture, forestry, civil engineering, electric power industry, and so on. Therefore, in order for DGUZ to be continuously competitive in this field, in early 2015 a prototype of 10-m tower with three levels of ultrasonic anemometers for micrometeorological measurements was built. This tower is currently being tested in the lee of Velebit mountain (south to the closest pass between the Pannonian basin and the Adriatic sea), at the front of the new Maslenica bridge, using the sampling frequency of 20 Hz at all three levels.

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HYMEX – FROM THE SCIENCE PLAN TO IMPLEMENTATION PLAN

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In recent years, an international project Hydrological cycle in Mediterranean Experiment (HyMeX) was launched to achieve a better general understanding of natural water cycle and improve hydrometeorological forecasts. Reasons for launching the Hymex project lie in the fact that the Mediterranean is one of hot spots for regional climate change. The Mediterranean area also concentrates the major natural risks related to the water cycle, including heavy precipitation and flash-flooding during the fall season, severe cyclogenesis associated with strong winds and large sea waves during winter, and heat waves and droughts accompanied by forest fires during summer. The Hymex project has focused on conducting both special observation periods (SOPs) and long-term observation periods (LOPs). An important goal of the project is also to advance state-of-the-art numerical models within a coupled atmosphere – sea – land modelling system across all weather and climate scales. Therefore, the project aims to improve the capability of predicting high-impact weather events, which remains moderate due to contribution of very fine-scale processes and their non-linear interactions with the larger-scale processes. On climate scales, in addition to temperature increase, a large decrease in the mean precipitation and an increase in precipitation variability are expected during dry (warm) season in future. Due to comparable amplitudes of climate change and internal climate variability, assessing regional climate evolution in the Mediterranean still remains a principal challenge.

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INVESTIGATION OF WEATHER-PBL HEIGHT DIURNAL COURSE RELATIONSHIPS IN THE PANNONIAN PLAIN DURING SUMMER PERIODS

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The Pannonian Plain is the largest Intra-Carpathian Plain located in the lowland part of the Carpathian Basin. The climate of region is continental with warm and frequently dry summers when both anticyclonic and cyclonic weather types are usual. These conditions are in favor for formation of highly variable planetary boundary layer (PBL) height diurnal courses where not only the atmospheric but also the land-surface effects can be strong. Based on these facts, we analyzed the weather-PBL height diurnal course relationships for each summer period (from June 1 to August 31) day of years 2012, 2013 and 2014 in two, climatically most different parts of the Pannonian Plain. WRF (Weather Research Forecast) PBL height diurnal course simulations obtained by Yonsei University scheme together with European synoptic weather charts for 00 UTC are used in analyzing the shapes of PBL height diurnal courses. The preliminary results suggest that three basically different shapes can be distinguished referring to purely anticyclonic and cyclonic weather types as well as to the weather produced by their mixed effects.

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ATMOSPHERIC NUCLEATION AND ITS RELEVANCE IN THE CARPATIAN BASIN

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New aerosol particle formation (NPF) and consecutive particle growth processes in the atmosphere were first identified in clean environments, and the NPF occurrence frequency and its contribution to particle number concentrations were later found to be substantial in the global troposphere. Particles originating from these processes affect the Earth's radiation balance mainly by acting as cloud condensation nuclei (CCN), and their contribution to the total number of CCN can be up to 50% or even more. Recently, NPF has been proved to be common in polluted environments including large cities, and hence, it can also contribute to the public's excess health risk from nanoparticle exposure. We investigated the effect of regional NPF on urban aerosol load under well-defined atmospheric conditions. The Carpathian Basin, the largest orogenic basin in Europe, represents an excellent opportunity for exploring these interactions with its extension, moderate climate and topographically discrete character, and because it contains a large city, Budapest, at its central part. We characterized atmospheric conditions of the city centre and near-city background of Budapest by performing continuous measurements of aerosol, air pollutant gases and meteorological data for two 1-year long time intervals. We completed similar measurements in the rural background at K-puszta station representing the regional atmospheric conditions over the same time intervals. Based on long-term observations, we revealed that NPF seen in a central large city of the basin (Budapest) and its regional background occur in a consistent and spatially coherent way as result of a joint atmospheric phenomenon taking place over large horizontal scales. We found that NPF events at the urban site are usually delayed by >1 hour relative to the rural site or even inhibited above a critical condensational sink level. The urban processes require higher formation rates and growth rates to be realised, by mean factors of 2 and 1.6, respectively, than the regional events. Regional- and urban-type NPF events sometimes occur jointly with multiple onsets, while they often exhibit dynamic and timing properties which are different for these NPF types.

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OVERVIEW OF THE (GROUND-LEVEL) OZONE PROBLEM: FORMATION, MEASUREMENTS, TRENDS AND IMPACTS (HUNGARIAN SPECIALTIES)

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Summary This study aims to present the general ozone problem in the troposphere and show the ground level ozone situation in Hungary using the monitoring data from three rural background monitoring stations. Monitoring data for the statistical analysis were available from 1990 to 2014 in case of K-puszta, while for the other stations only from 1996 to 2014. Annual trend analysis, exceedance of ozone thresholds, frequency distribution and AOT40 calculation were performed.

Introduction Ground-level or tropospheric ozone (O3) is an oxidant air pollutant that has harmful effect on human health and vegetation, however a short-lived greenhouse gas. Ozone is a secondary pollutant, which means that it is not directly emitted in the ambient air, but also produced from the photochemical oxidation of non-methane volatile organic compounds (VOCs), methane (CH4), or carbon monoxide (CO) in the presence of nitrogen oxides (NOx). Ozone is also produced in the stratosphere (from the photolysis of oxygen) and could be transported into the troposphere, which is the most essential natural source of the ozone in the ground level. Ozone is destroyed both photochemically and through deposition to the surface. Summarizing the chemistry of ozone is complex and non-linear. The long-range transport of tropospheric ozone and its precursors have important impact on O3 concentrations at regional and local scales. Background concentrations of ground-level ozone in Europe don't show a significant downward trend (Wilson et al., 2012), but in Hungary essential reduction was observed at K-puszta and Farkasfa stations in the last decades.

Methodology and Results In Hungary the Hungarian Meteorological Service is responsible for the rural ground-level ozone measurements. The institute maintains three background monitoring stations, where the tropospheric ozone measurements are carried out beside the observation of any other pollutants. Since the stations are located in different geographical environment from plains to mountain, this effect is reflected in the measured data. Atmospheric lifetimes of ozone precursors are long enough to allow them to be transported on long distance but the range of the impact depends on meteorological and geographical conditions. Although the stations are located in background areas, the local topography and surroundings are different. These circumstances undoubtedly may influence the ozone concentration. We assumed that the trends are linear, and the trends are calculated by de-seasonalising the ozone time series. Mann-Kendall analysis of Sen-Theil slopes were used for the calculations In case of Farkasfa and K-puszta stations decreased trends can be observed, while in case of Nyírjes station the trend is increasing in average but there are intervals when the ozone concentration decreased for a few years (between 1997-2002 and 2009-2014). The monthly means of ozone concentration were also determined for the three stations. The results reflect that the ozone has different yearly variation on the sites. The biggest amplitude can be observed at K-puszta while the lowest at Nyírjes. This result is reflects the fact that Nyírjes is a mountain station where the

amplitude of the monthly and the daily ozone concentrations are much lower than at the plain stations. The results of the frequency distribution examination shows that the highest ground level ozone concentrations can be expected at Farkasfa in June and July, at K-puszta in June, July and August while at Nyírjes only in July. Despite a Hungarian decline in ozone concentrations trends, AOT40 did not show any trend. In case of K-puszta the AOT40 exceed the limit value in most cases. While at Farkasfa the calculated AOT40 never has been exceeded the limit value and in Nyírjes the AOT40 exceeded the limit value only in some cases. Conclusions In this work the recent results on ozone levels and trends at background sites located in Hungary are discussed. Studies have shown that concentrations of ozone in the Hungarian background stations are influenced by emissions of precursor gases outside the continent. In case of Farkasfa and K-puszta stations decreased trends can be observed, while in case of Nyírjes station the trend is increasing. After several statistical analysis it can be concluded that K-puszta station might be better termed "urban-affected", because of advected urban plumes from Budapest that affect concentration characteristics. Nyírjes and Farkasfa are beyond the reach of urban plumes or other anthropogenic effect can show small seasonal variations in ozone concentration.

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PRECIPITATION CHEMISTRY TRENDS IN CROATIAN PART OF THE DANUBE REGION

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The spatial, temporal and trend changes in precipitation chemistry in Croatia during 1981-2016 were analysed using the data from 18 sampling sites spatially distributed over Croatian territory. Volume weighted concentrations of main ions in precipitation samples (sulphate, nitrate, chloride, ammonium, calcium, magnesium, sodium, potassium) and acidity are calculated for each year and season. The trend analysis was performed and tested by nonparametric Mann-Kendall test and Sen's slope estimator.

Results showed that sulphate and nitrate ion concentrations significantly decreased for majority of sites in central and southern regions of Croatia. The main decline of sulphate ion concentration occurred after 1990. Changes in anthropogenic sulphur emission patterns over Europe in the last two decades resulted in different acidity and sulphate ion concentrations in relation to particular sector compared to earlier times. In additions, precipitation chemistry is influenced by geographical and climatological diversity. While central and southern parts of Croatia exhibit similar trend behaviour (trend slope and significance level), results for Pannonian region show a much slower decrease without statistical significance. Therefore it cannot be assumed that decline of atmospheric deposition of pollutants is significant. Main reasons could be related to the fact that in most neighbouring countries (Slovenia, Serbia, Bosnia and Herzegovina, and Bulgaria) locally mined coal with higher content of sulphur is used in industry and electrical power generation as major fuel. This became much more pronounced since 2008 with economic crisis that also reversed the trend of cleaner fuel usage for residential heating. Due to the lower prices households started to use again cheaper solutions like wood or coal burning instead of already introduced natural gas. Effects of these behavioural changes are therefore measurable in precipitation chemistry of the last decade in Croatian part of Pannonian basin.

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MONITORING THE URBAN HEAT ISLAND AND ITS IMPACT ON THE INDOOR THERMAL RISK IN BUCHAREST (ROMANIA)

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Bucharest is the largest city of Romania, with about 2 million permanent residents, important economical assets and extended built-up area, placed in a temperate climate with continental influences reflected in hot summers and rather low precipitation amounts. Heat waves and extreme temperature events occur each summer triggering health problems and upsetting the economy. The size and the structure of the city generates a noteworthy urban heat island (UHI) which is often strengthening the impact of high temperatures. At present, the monitoring of Bucharest's climate is secured by 3 standard WMO meteorological stations and 6 urban sensors collecting air temperature (AT) data, while satellite remote sensing have become a valuable tool in the last 10-15 years for providing land surface temperature (LST) at different resolutions. The main characteristics of the Bucharest's surface UHI, such as intensity, diurnal variations or spatial extension, were explored in relation with land cover and other co-variables, and the outputs have been used for investigating the indoor thermal risk in residential buildings. Using the statistical relationships between AT and LST, on one side, and the specific thermal and functional characteristics of the buildings, on the other side, the indoor climate was dynamically modelled with an hourly resolution for few test locations. The thermal risk was determined using standardized comfort indices, e.g. Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD), and the Excessive Natural Thermal Regime Risk was defined by risk classes ranging between "no risk" and "life endangering". The methodology may be exploited operationally for issuing warnings and alerts when the indoor thermal risk reaches unacceptable levels, and it can be easily transferred to other cities. This research was supported by the Romanian Ministry of Education and Research, PCCA Partnerships Collaborative Projects 2013, PN-II-PT-PCCA-2013-4, Reducing urban heat island effects to improve urban comfort and balance energy consumption in Bucharest, acronym REDBHI.

ADAPTATION AND SENSITIVITY STUDY OF CMAQ–SMOKE–WRF AIR QUALITY MODEL SYSTEM FOR OZONE PRECURSOR EMISSIONS IN CARPATHIAN BASIN

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The Department of Meteorology at Eötvös Loránd University adapted the WRF (Weather Research and Forecasting) model several years ago, which is suitable for weather forecasting tasks and can provide input data for various environmental models (e.g. DNDC, AERMOD). By adapting the CMAQ (Community Multi-scale Air Quality) model we have designed a combined ambient air-meteorological model (WRF–CMAQ). We used WRF model in order to generate the meteorological driver database and the so-called SMOKE (Sparse Matrix Operator Kernel Emissions) model for generating input emission database. WRF–CMAQ model system has been run on a three-level one-way nested grid with 108/36/12 km grid spacing covering Central Europe, the Carpathian Basin and Hungary, respectively. We have used CMAQ 5.0.1 version which includes i) an updated version of the carbon-bond "CB05" gas-phase mechanism (with active chlorine chemistry and updated toluene mechanism), ii) sixth-generation aerosol mechanism (including sea salt and specialized PM among others), iii) Cloud module, etc. For improving the quality of simulations we have used the Geos-Chem model results as initial and boundary conditions. First we introduce the main model attributes and the selected case of our studies. The structure of the model system and a case study (an anticyclonic weather situation at September 2012) are presented for Europe and the Carpathian Basin. Verification of ozone forecast was based on the measurements of background air pollution stations. Effects of model attributes (e.g. transition time, emission dataset, parameterizations) in ozone forecasting were also investigated.

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INFRASOUND MEASUREMENTS FOR THE DETECTION OF LOCAL AND REMOTE TURBULENCE

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Infrasound measurements are mainly used to detect coherent signals such as seismic waves and a large effort is devoted to eliminate the turbulence-related infrasound signal, usually considered as noise. In our measurements, we took a complementary approach, investigated whether infrasound could provide information on atmospheric turbulence. In a micrometeorology measurement campaign (2013 fall, Hungary, Szeged) as a trial two microphones were also mounted to record infrasound signal. The reference turbulence detectors were a sonic anemometer and a SODAR. The comparison of infrasound integrated spectral energy to turbulent kinetic energy from the sonic provides a good match when turbulence is present near the ground. Moreover, on stable nights when the surface layer is strongly stratified and with turbulence absent, microphones sometimes recorded infrasound when the SODAR showed a low-level jet above the surface inversion, indicating that microphones may be used as detectors of elevated turbulence. The measurements, the data evaluation and some of the more interesting results are to be presented.

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CROP PRODUCTION ADAPTATION TO CLIMATE CHANGE

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Climate change may have various impacts on agri-environment inducing alterations in the ecosystem by physical, chemical and biological means. There is a climate change process, and we have to handle that, let it be anthropogenic fully, partly or not at all. Crop production and the land use system applied highly depend on the adaptation techniques. Novel methods in soil tillage, plant nutrition, crop production have been developed and field crop varieties have been tested concerning adaptibility to climate change at the Crop Production Institute of the Szent István University, Gödöllő, Hungary.

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DROUGHT MONITORING IN SLOVENIA AND SE EUROPE - STATUS AND PLANS FOR THE FUTURE

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Droughts in Slovenia have been traditionally analysed using computation of meteorological water balance. Drought onset and termination as well as intensity and potential impacts can be assessed with computed difference between precipitation and evapotranspiration and improved with use of auxiliary data such as prevailing types of crops, information on actual phenological development of plants and possible irrigation application. Similar approach is used also for preparation of regional drought monitoring products, which are being prepared in vegetation period for ~6 years by Slovenian Environment Agency which is hosting Drought Management Centre for SE Europe (DMCSEE). For regional monitoring products, different approach had to be applied due to difficulties in gathering observation data from various countries in the region. Therefore drought monitoring products are based primarily on NWP simulations. More recently, remote sensing data has been applied to monitor drought impacts. As first source, EUMETSAT LSA-SAF data has been used to prepare assessment of deviation of vegetation condition from normal state (calculated from few year of archive). Lack of archived data is one of main disadvantages of climate products obtained by remote sensing data. Despite this fact our main plans for future development of drought monitoring products are based on new available remote sensing data, mainly obtained by the Copernicus programme.

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HYDROMETEOROLOGICAL FORECASTING AND EARLY WARNING SYSTEMS

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Climate change belongs to the largest environmental problems in our days. Therefore, we have to adapt to it, and the early warning system (EWS) is one of the mostly used adaptation activities to climate change. EWS has four main parts: risk assessment, monitoring and forecast, dissemination of results and responses. Dissemination of results means stakeholder dialogue, science-policy-interface (SPI).

In case of water related disasters, GEWEX covers large part of the EWS, therefore, GEWEX could serve input for drought and flood EWS. From the other side, different disasters require different spatial and temporal scales. Drought has effects on the largest scale comparable with the Basin spatially, and weekly upwards temporally. For floods, river flood could have the same scale as the drought or smaller, flash flood needs temporally and spatially small scale information.

Large amount of investigations deals with risk assessments. Following the European Union Water Framework Directive (EU WFD) and the Communication of the EU Expert Group on Water Scarcity and Drought, drought strategies were developed in the countries and Flood Directives were launched on European and national levels. These documents contain risk assessments for the case of flood, mostly river floods. Research works are planned and ongoing on drought risk assessments.

Strong national features can be detected at least two basic systems from the three (risk assessment, monitoring and forecast). Therefore, harmonisation activities are requested at the development of Basin wide, different scale catchment water balance estimations. This activity has to be established on the work has been done by the countries to give usable information for transnational and comparable information for national catchments.

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DANUBECLIM - AN EXTENSION OF THE CARPATCLIM PROJECT

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In the frame of the CarpatClim project homogenized daily gridded climate data series were prepared for the main meteorological variables and for the period 1961-2010. The grids cover the area between latitudes 50°N and 44°N, and longitudes 17°E and 27°E, including parts of Czech Republic, Croatia, Hungary, Poland, Romania, Serbia, Slovakia and Ukraine.
Main advantages of the project were:
- Every country homogenized and interpolated their own station data series itself and only the gridded data got into the common dataset.
- Homogenization and interpolation procedures were the same in the participating countries (MASH-MISH, developed at Hungarian Meteorological Service)
- Near border data exchange was implemented to avoid the breaks at the borders.

Recently the spatial extension of these gridded data is under execution. Through bilateral contracts with the Joint Research Center of the EU new regions entered in the project called Danubeclim Database. The applied methods are the same as in CarpatClim project. The new areas are:
- Republika Srpska from Bosnia Hercegovina,
- Montenegro,
- Southern part of Serbia,
- Western part of Hungary.

Practically the project has begun at the beginning of 2016 and the expected daedline is the end of this year. The resulted data series will be uploaded on the Carpatclim homepage.

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CLIMATE OF THE CARPATHIAN BASIN ACCORDING TO FEDDEMA USING THE CARPATCLIM DATASET

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The Carpathian Basin has a particular climate in the Central European region. It possesses specific soil and vegetation types that is supported by a varied climate affected by the vicinity of the Mediterranean Sea, the Atlantic Ocean, the high pressure weather systems originating from Siberia and the blocking effect of the surrounding Carpathian Mountains. According to early 20th century climate classification methods, the spatial heterogeneity of Carpathian Basin's climate seems pretty low that can be explained by extended low land parts of the Basin. Feddema's (2005) method is one up-to-date global climate classification method, which was not applied so far for characterizing this region's climate. The aim of this study is to apply this method to the Carpathian Basin and making adjustments for regional application. CarpatClim dataset refers to the region located between 44°N-50°N/17°E-27°E latitude/longitude lines and the time period 1961-2010. Monthly temperature and precipitation data is organized in a spatial resolution of 0.1° x 0.1°, which is the best available resolution for the study area. The preliminary results suggest that the spatial heterogeneity of the climate is higher than as it was obtained by Köppen's and Holdridge's methods.

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SOME TEMPERATURE INDICES UNDER CURRENT AND PROJECTED CLIMATE CHANGE CONDITIONS IN THE TRANSCARPATHIAN LOWLAND OF UKRAINE

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The temperature regime of the atmosphere is one of the important characteristics of the natural environment. Lengths of the periods with air temperatures above certain values, and dates of their start and end are the main indicators of the thermal regime that are widely used to solve a number of theoretical and applied problems. These data are used to determine the characteristics of climatic seasons, solving a number of agro-meteorological, environmental and other problems. In the presented study dates of transition of the average daily air temperatures over fixed values of 0, 5, 10, 15 degrees Centigrade have been determined for three climatic periods: standard 1961-1990, modern 1981-2010 and projected 2021-2050 for five stations in the Transcarpathian lowland of Ukraine. Lengths of periods with temperatures above these values, as well as changes of temperature transition dates in modern climate conditions regarding the standard and in the projected relatively modern were analyzed too. The study used the average daily values of air temperature database E-Obs, version 10.0, as well as the results of calculations of 6 regional climate model (RCM) of the European FP-6 project ENSEMBLES (REMO, RCA3-E, RegCM3, RACMO2, RM5.1 (Aladin), HIRHAM-BCM) calculated for SRES A1B. Generally, it was found that winter season with temperatures below zero almost didn't changed yet in modern period comparably to standard, but will be dramatically shorten by almost two months and will last to less than 20 days till the middle of the 21st century. At the same time lengths of other periods are projected with much less prolongation of 4-14 days. Results will be presented in specially worked out graphical diagrams suitable for quick visual assessments.

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UNCERTAINTY AND VALUE OF PRECIPITATION PROJECTIONS FOR THE CARPATHIAN BASIN

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Besides temperature, precipitation is a key meteorological variable of the adaptation issues: both its deficit and also its surplus can cause severe problems in everyday life. Therefore, it is used as essential input parameter in vulnerability studies of most sectors (e.g., hydrology, agriculture, tourism). To obtain reliable results, proper description of its present and future distribution (both in space and time) is of high importance. Oddly, with state-of-the art climate models it is still challenging to simulate the precipitation formation processes with high accuracy due to their large variability and parametrization-type description. For this reason, it is indispensable to quantify the uncertainty of precipitation estimates in impact assessments which is possible with the ensemble approach using outputs of several model runs instead of a single experiment. Various international and national ensembles of climate model simulations are available for our region of interest (the Carpathian Basin), e.g., CMIP3, CMIP5, ENSEMBLES, EURO-CORDEX, NAGiS. They are different in some aspects like the applied climate models (global vs. regional ones), the utilized anthropogenic forcings (SRES vs. RCP scenario family), the grid resolution or the represented uncertainty sources. The presentation aims at showing some illustrative outcomes of our assessments regarding the leading uncertainty factors of precipitation projections, their applicability and limitations in objective impact studies.

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POSSIBLE CONTRIBUTION IDEAS TO A COMPLEX PANNONIAN STUDY

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The potential regional consequences of global warming may affect several sectors, e.g. large cities, agriculture, water management, energy supply, etc. The Pannonian Basin is one of the most exposed and vulnerable regions of Europe from the climate change point of view. Therefore, the region could clearly benefit from a complex analysis of estimated impacts taking into account new RCP scenarios. The main pillars of such an analysis could be as follows:
(1) the analysis of projected trends in soil humidity associated with extreme hot conditions;
(2) the new experiments of regional climate models with improved soil and land use characteristics;
(3) the large scale analysis of continental circulation patterns inculding the North Atlantic Oscillation (NAO), the blockings, and the changes of midlatitude cyclone tracks and the polar jet;
(4) detailed urban modeling studies;
(5) a detailed analysis of the frequency and the intensity of extreme events, including both climatological and hydrological extremes.

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EDUCATION, KNOWLEDGE TRANSFER AND OUTREACH

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Qualified and competent personnel are essential to the success of National Meteorological and Hydrological Services (NMHSs) around the world. Also, due to high level of cooperation needed in international field of Meteorology, similar scientific achievements should be acquired by students before being hired by these institutions. This paper aims to an investigation of study programs in Meteorology-Climatology in PannEx area, and a quick overview has been done until now for six countries in the region: Croatia, Czech Republic, Hungary, Serbia, Slovakia and Romania.

Thus, twelve universities were found to provide higher education in Meteorology, at different levels (Bachelor, Master, and Doctoral) identified in the PANNEX area are: two in Croatia (Zagreb and Split), one in Czech Republic (Charles University in Prague), three in Hungary (Eötvös Loránd University, University of Debrecen and University of Szeged), three in Romania (University of Bucharest, Babes-Bolyai University of Cluj-Napoca, and Al. I. Cuza University of Iasi), two in Serbia (University of Belgrade and University of Novi Sad), and one in Slovakia (Comenius University in Bratislava). In some universities, students can choose among more than one field of atmospheric science for PhD. studies in the same university (e.g. University of Bucharest where two quite similar PhD. studies can be followed by students in two faculties: Meteorology and Climatology in Faculty of Geography and Atmosphere Physics in the Faculty of Physics).

Unfortunately, very few information is available in English, so that a detailed analysis of specific study programs could not be achieved, but cooperation between universities in order to harmonize the study programs at different levels can be developed under the framework of PannEx program.

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CLIMATE AND DROUGHT MONITORING USING SATELLITE DATA

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The long term vegetation maps can be used to investigate the climate change and the effect of the extreme weather phenomena. NASA has derived vegetation maps from MODIS satellite data since 2000. The Hungarian Meteorological Service investigates these vegetation maps for climate change and drought monitoring. The 16 day MODIS vegetation maps and yearly land cover has been archived and investigated since 2003. In the poster we present the vegetation maps between 2010 and 2015 for the Charpatian Basin, showing the effect the extreme weather, such as 2012, which was very dry year, while 2010 was very wet. Separating the forest, agriculture and grassland area we investigated the annual changes of them for 2010-2015 period. . Finally we present the Pálfai drought index derived from MODIS data, comparing the Pálfai index determined from surface measurements.

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DUAL CHANNEL PHOTOACOUSTIC HYGROMETER FOR AIRBORNE MEASUREMENT OF CLOUD WATER/ICE CONTENT

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A tunable diode laser based dual channel photoacoustic humidity measuring system which is primarily designed for aircraft based environment research is described. The unique advantage of the presented system is its applicability for simultaneous water vapour and total water volume mixing ratio measurements. The system is already applied successfully in various airborne measurement campaigns.

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THE IMPACT OF LAND USE AND LAND COVER CHANGES ON LAND SURFACE TEMPERATURE OF ADDIS ABABA CITY, ETHIOPIA

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Urban heat islands (UHI) are a clear, well-documented example of an anthropogenic modification to climate that has an atmospheric, biological, and economic impact. This review shows how satellite-based and modeling studies continue to help unravel the factors that are responsible for urban heat island development and are providing a basis for the development and application of sustainable adaptation strategies. As urban areas continue to expand as a result of land use land cover changes, there is a heightened awareness that scientific knowledge of the urban heat island must be more effectively communicated to architects, engineers, and planners and translated into intelligent urban design. Green roof technology and greening of urban set up is a case in point. This and other technologies are being slowly adopted, and research published since 2003 suggests that the pace with which many practical applications are put into practice should accelerate.

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MESOSCALE CIRCULATIONS UNDER HIGH-PRESSURE CONDITIONS IN THE PANNONIAN BASIN

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This work inspects, using ECMWF analyses, a number of anticyclonic warm and cold episodes, the later with and without fog. A barometric dam over the basin and its surroundings allows to see the mesoscale flows generated by the topography and their interactions, and how they are modified when ex- tensive fog appears. A second category includes high-pressure only partially on the basin and its surroundings. Then, Bora flow may appear on the Adriatic coast or southern flow be directed towards the northern European plain, leaving areas where local mesoscale circulations still prevail. Analyzed fields show to be well suited to analyze these regimes, although some discrepancies with observations at screen level are found. The characteristics of shallow strong surface inversions or slope flows are usually not well represented. Nevertheless, it is clear that low level circulations develop at the basin scale, generated at the mountain areas and locally at the main river valleys. These circulations may converge in the lower terrain areas for high-pressure conditions or contribute to the more general synoptic forcing.

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CLIMATE CHANGES AND WEEDS

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Climate change is one of the main factors that affecting the entire agroecosystem. This takes place in different ways and leads to shift in productivity and stability of agricultural production systems. One of the indirect ways in which climate change is affecting crop production is weeds occurrence. Weeds represent very important factor in crop production due to the strong influence from an economic and environmental point. Weed communities on arable land are widespread and highly variable component of the vegetation in Pannonian basin. Climate changes affect the composition of the weed flora directly through environmental conditions (changed temperature and precipitation, increasing CO2 concentration in the atmosphere, frequency and intensity of extreme weather events) and indirectly through changes in land use and management practices which are the result of adaptation to climate change. Compared to crops, weeds have a greater genetic diversity and the ability of adapting to new conditions. With changing of a basic resource such light, water, CO2 and plant nutrients in the environment, it is expected that weeds will be better in growth and reproduction response related to crops. Increasing temperatures can contribute to the expand of weeds from the warmer areas and thus affect the competitive balance between crops and weeds species, intensifyng weed pressures. Changes in rainfall and water availability can have an influence on biological properties of weeds (germination, plant size and seed production). Moreover, a decrease in annual precipitation could lead to distribution of weeds from the dryer regions. Consequences of increasing CO2 affects weeds and weed/crop competition in different ways depending on the mode of energy capture (photosynthesis). C3 weeds may grow more rapidly under higher carbon dioxide levels and become more competitive. Extreme weather events like droughts, floods, heatwaves, storms and fires can cause native vegetation stress and lead to colonisation of bare areas with invasive weeds. All above may cause great changes in weed distributions and competitive ability. Weeds in agroecosytem are well adapted to the environmental conditions resulting from the various farming practices. In addition, they are closely related with the cropping system. Since the land use management is affected with climate change this has indirectly influence on weeds as well. Adopting cropping systems and management measures to new climate conditions (different crops, crop rotations, sowing dates, conservation tillage methods) has an indirect influence on the weed occurrence. The need to research climate change effects on weed populations will increase in the future since the weed management is a significant ecological, financial, logistical and research challenge.

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CAN BIOCHAR MITIGATE CLIMATE CHANGES?

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The world food demand grows due to the increasing number of population. By taking into account climate changes, constant increase in prices of the production inputs and rising ecological awareness of population, the food production becomes very challenging and requires every agricultural producer to quickly adapt to this newly arisen situation. Modern agricultural production is under the great influence of the climate changes, and regarding that, adaptation too many challenges will be in order in the near future. Scientific community is constantly trying, on the one hand, to detect the problems caused by the climate changes, and on the other to mitigate them, to adapt to their influences. One of the frequently mentioned ways of mitigating climate change is the application of biochar. Biochar is the product obtained through the treatment of heating up the biomass with little or no oxygen to the point at which the treated product holds 70 to 95% of carbon. Currently there are several thermo-chemical processes of biochar production, mostly based on pyrolysis, which is simple, economical and energy efficient process of biochar production from the "waste" biomass. According to the results of the researches on biochar as soil conditioner, it is concluded that biochar positively affects a number of physical, chemical and biological soil properties. Biochar is highly resistant to microbiological decomposition and mineralization and it can retain in the soil up for few hundred years. Also, biochar has one more respectable advantage and that is that by the usage of biochar we are sequestrating the carbon in the soil which directly influences the greenhouse gasses (GHG) emission. Some of the researches on biochar show that by switching from the traditional method of disposal of organic matter to biochar production, it is theoretically possible to stabilize 0.2 Gt of carbon, which is about 0.7 Gt of CO2 on the global level. Most of the researches on biochar were conducted in tropical and sub-tropical regions, while its effect on the continental climate is being researched during the last few years. Also, it is important to mention that the effect of biochar on the carbon sequestration depends on the quality of feedstock material which may vary considerably, but also on the method of pyrolysis used in the process of production. That, of course, indicates the need for further researches on this matter, because most of the mechanisms contributing to the reduction of GHG emissions are not yet completely explained, and require many years of research under different environmental and agroecological conditions and also on the number of different agricultural crops.

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ASSESSMENT OF WARM SEASONAL DROUGHTS IN TRANSCARPATHIA UNDER PAST AND FUTURE CLIMATE CONDITIONS

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Transcarpathian region is a small area of west part in Ukraine, which belongs to the Carpathian foothills and characterized by distinctive climatic conditions. The study considered the drought conditions in warm seasons (April-October), which were observed during period of 1950-2011 and expects during future period of 2020-2050 for Transcarpathian region. For analysis was used two drought indicies: the SPEI (Standardized Precipitation Evapotranspiration Index), which is based on monthly data of precipitation and potential evapotranspiration, and the SPI (Standardized Precipitation Index), which is based only on monthly data of precipitation and recommended by WMO for using in drought monitoring. The SPEI calculated and analised for time scale of 7 month, which covered vegatation period, for five stations, such as Chop, Golatin, Znyatseve, Yasinya, Zhornava, and which corresponds to centers of gravity of the watershit for main river Transcarpathian rivers. Analysis of the SPEI7 time series shown that for most of station four episodes of sever (SPEI < -1.5) and extreme (SPEI < -2.0) seasonal droughts were observed: in 1961, 1976, 2000 and 2003. The most important drought occurred in region in 1961, when the SPEI7 decrease to -2.5. The dry episodes of any intensity (SPEI<0) occurred almost every second year. Moderate seasonal droughts observed on each station in 5 to 8 years. During the research period there is not significant trend of SPEI for all station. The main wet period appeared from 1972 to 1982. Beginning and end of study period is characterized by more dry conditions. For assessment of the drought frequency in the future was used data of CMIP5 (Coupled Model Intercomparison Project, phase 5) for period 2020-2050. Analysis of spatial and temporal distribution of seasonal drought was held using the index SPI. For its calculation has been used multimodel (32 models) monthly mean precipitation data for two boundary scenarios, which represents the RCP (Representative Concentration Pathways), experiment RCP2.6 and RCP8.5. The SPI analysis on the 7 month time scale during the vegetation period shown that for both scenarios the total number of expected droughts is almost equally. The frequency of weak and moderate seasonal droughts is averaged to 13-14 cases per 31 years. But amount of severe and extreme droughts is different in both scenarios. Under scenario RCP2.6 intensive droughts are expected in 1 to 2 years, under scenario RCP8.5 total amount increased up to 3-4 cases per 31 years. Compared to present conditions, the total number of droughts in near future almost not changes, but probability of severe and extreme drought is increases.

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MODERN HYDROCLIMATIC CONDITION OF FORMING MINIMUM RUNOFF TRANSCARPATHIAN RIVERS AND POSSIBILITY IT MODELING

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Global and regional climate changes have an impact on the water regime of rivers as a whole and on its individual components. In particular, in recent years, is increasing frequency of extreme events such as floods and droughts. Formation of minimum river runoff is closely linked with the previous climatic conditions, and the advent different type of drought (meteorological and hydrological) reduces the supply of ground and surface alimentation rivers. The described area belongs to the Ukrainian Carpathians mountain country. In this area, allocated 10 gages that have observation for minimal runoff of river. To analyze the formation conditions of minimum flow in the investigated territory used drought index SPEI on different time scales. The objective of this work was to study the relationship between values SPEI for different time intervals and minimum values of runoff Transcarpathia rivers. Such a relationship exists, but its extent varies as the changing time intervals which are designed SPEI months and for which they are designed. Thus, for the winter time, the largest value of the correlation coefficients obtained for March and April, and for summer low flow - for August, September and October. Besides using the drought index, in the work was estimated change in the average temperature and precipitation from 2011 to 2050 for the weather station Uzhgorod on scenarios RCP 4.5 and RCP 8.5. Forecasted average temperature in both scenarios show a positive trend with significant correlation coefficients, with regard to rainfall, the correlation coefficients here is not significant. Using equation multiple linear regression has been calculated forecasted value of the minimum flow during the summer and winter time for river Uzh – town Zhornava. • The forecasted value for the summer low in both scenarios have insignificant negative trend, but for some years there are significant deviations these value in both downward and increase. • For winter time the overall trend is almost zero, but for the entire period is characterized by relatively large fluctuations. Thus, the results open perspectives in predicting future minimum flow with the use of the index SPEI, and global climate change scenarios.

EFFECT OF CLIMATE ON SOME SOIL PROPERTIES AND CROP PRODUCTION

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Climate with amount of rainfall, temperature and evaporation significantly affects the processes of the formation soil types. With intensification of climatic aberrations due to climate change, pedogenetic processes are also intensified. These processes influence physical, chemical and biological soil properties, and finally crop production. In areas with an average rainfall above ≈650 mm the process of eluviation or leaching clay particles, organic matter and oxides of iron and aluminum are also more intensive. Accumulation of clay in the deeper layers of the profile leads toward the horizon that considerably makes difficult water percolation of water and water remains on soil surface. With this processes of disturbed water:air ratio, degradation is crucial problem for earlier sowing in spring (soil warm up slower). In this way soil chemical properties are also degraded and nutrients become more unavailable. At the other hand, in area with smaller amount of water, in arid or semi-arid climate, as another form of soil degradation is salinization and alkalization, which becomes more and more serious problem. These processes can lead to formation of halomorphic soils; solonetz (alkaline) and solonchaks (saline). These are soils with very poor chemical and physico-mechanical properties, which are mainly used as pastures. In that soil conditions crop production becoming questionable and some measures must be applied (usually very expensive) for soil correction and improvement. Intensifying individual climatic events (drought, wind, flood, etc.) significantly effect on intensification of certain processes degradation of soil properties. These soils are very poor chemical and physico-mechanical properties, which generally leads to their usage conversion.

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MICROSCALE PROPERTIES OF BORA TURBULENCE AT THE NEW MICROMETEOROLOGICAL RESEARCH FACILITY

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Bora macroscale and even mesoscale features have ben intensively investigated in the past few decades, but the important details about bora microscale properties are yet not known well. One of the reasons for this inadequacy is the lack of measurements suitable for bora microscale investigations. Those are high-frequency in situ measurements of wind speed and temperature in space (e.g., detailed aircraft measurements) and in time (single point ground based measurements on e.g., meteorological towers/masts), as well as bora remote sensing. Therefore, Department of Geophysics, University of Zagreb, Croatia, conducted several projects in the past 10-15 years within which high-frequency measurements of the wind speed and temperature along the eastern Adriatic coast have been performed. These are single point measurements at the town of Senj, Vratnik Pass and Pometeno Brdo (Swept-Away Hill, hinterland of the city of Split). However, all those measurements were performed using sonic anemometers mounted on the towers/masts at 10 m and higher above the ground, leaving the turbulence structure of the bora wind below 10 m undisclosed (important for traffic and agriculture). Thus, here we present a new state-of-the-art micrometeorological tower measurements installed 200 m in the front of the new Maslenica Bridge (≈ 30 km NE of the city of Zadar, on the main motorway), in the lee of Velebit mountain. The tower 10 m tall, equipped with three levels of Gill WindMaster ultrasonic anemometers (2, 5 and 10 m), gathers continuously the 3D wind speed and sonic temperature with the sampling rate of 20 Hz since 09 October 2015. Most of the analysis and background theory is covered within our PhD course 'Selected chapters in atmospheric turbulence'. Using Fourier spectral analysis, we investigate a suitable turbulence averaging scale and bora gust pulsations. The obtained data set is further used for testing the Monin-Obukhov similarity theory and the degree of closure of the prognostic TKE equation. These are expected to be considerably modified due to the complexity of the terrain and effects of vigorous air-sea-land interaction. Finally, the growing expertise in micrometeorological measurements is offered here for future collaboration within the scope of PannEx.

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PABLS'15 PLANETARY BOUNDARY LAYER MEASUREMENT CAMPAIGN, SZEGED

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PABLS '15 campaign (Pannonian Atmospheric Boundary Layer Experiment Szeged) took place in the summer of 2015 as a result of extensive cooperation among several Hungarian and international institutions. The main goals of the expedition included i) observing the development of PBL, ii) comparing different instruments and measurement methods, iii) analyzing nocturnal stable boundary layer, and iv) implementing precise measurements of PBL-related atmospheric conditions. During the expedition's main part, four intensive observation periods (IOPs) took place, where the vertical profiles of nocturnal stable boundary layer were examined with the use of tethered balloons and multicopters. These IOPs were carried out between 10th and 17th of July, 2015. First we present the instrumentation then some results of the processed data are demonstrated (profile comparisons). The automatized SYNOP, METAR and TEMP processing software, which was created in the data processing period for the NWP model comparison is also illustrated. The development of nocturnal boundary layer is presented via a case study using the balloon measurements with modified GRAW radiosonde. Finally the calculation of surface fluxes and uncertainty of energy budget closure are demonstrated.

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NEAR-SURFACE WIND PATTERNS OBTAINED BY REGIONAL CLIMATE SIMULATIONS FOR SOUTH-EASTERN EUROPE

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This study examines simulated and observed near-surface wind speed from multiple sources. Observations include numerous land-based station data from the 1996-2008 period and QuikSCAT data from 2000-2008 period over the Adriatic. Observed data have been compared against the daily output from a suite of 10 CORDEX RCM simulations (seven from EURO-CORDEX: CLMcom-CCLM4-8-17, DMI-HIRHAM5, IPSL-INERIS-WRF331F, KNMI-RACMO22E, SMHI-RCA4, CNRM-ALADIN5.3 DHMZ-RegCM4.2, and 3 from MED-CORDEX: CNRM-ALADIN5.2, ICTP-RegCM4.3, UCLM-PROMES), where all simulations are forced by the ECMWF ERA-Interim reanalysis. Each ensemble member was run at two resolutions; 12.5 km and 50 km. Furthermore, for the proper comparison between 12.5 km and 50 km resolution simulations, the upscaling of the 12.5 km model resolution is performed. RCMs with fine grid spacing have improved characteristics of regional topography, while at the same time spatial patterns of surface wind are strongly affected by the complex topography. The flows over the Adriatic, (i.e. bora and sirocco along the Adriatic coast) differ from wind characteristics inland where the Danube river splits Pannonian Basin into two parts surrounded by the Alps in the northwest, the Dinaric Alps in the southwest and by the Carpathians in northeast. Results from the same RCM but with different grid spacing reveal strong dependence of wind characteristics on location. When comparing RCMs and observations, we discuss statistical approaches (e.g. Brier skill score and principal component analysis). Furthermore, RCMs are explored in terms of skill in reproducing specific wind regimes where sometimes large spread in the RCM ensemble has been found.

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METHOD OF DETERMINING THE MAXIMUM FLOOD RUNOFF FOR UNGAUGED RIVERS OF THE UKRAINIAN CARPATHIANS

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In today's climate change, both in Ukraine and in the world as a whole significantly increased probability of extreme opposite in hydrological phenomena - floods and droughts. Scientific work aimed at solving important applied problem - the development of scientific and methodological basis for the calculation of flood runoff characteristics of mountain regions of Ukraine, based on modern scientific achievements in the field of theoretical and applied hydrology, which have no analogues in other countries. Scientific and methodological base in calculating the maximum flow characteristics in most countries are based on a synthesis of experimental materials observations using theoretical models based on the geometric schematization hydrographs of floods. Disadvantages of simplistic approaches are it the structural base that had not takes in account time trends is due, for example, climate change or economic activity. The use of methods envelope of experimental data dependencies ignores the features in miltifactorial processes formation of streamflows in some catchments. In Odessa State Environmental University there exists scientific school "Theoretical and Applied Hydrology" that has recognized in Ukraine and abroad and which has its main focus is the study of the formation of catastrophic floods. Depending on the environmental conditions prompted several theoretical submodels on which possible building the regulatory procedures in the area of maximum flow. The authors proposed the variant of calculation scheme, realizing principal two operator's model of drainage formation. It is obvious that two operators must describe the process of formation of channel runoff: "precipitations – slope influx" and "slope influx – channel runoff". To justify the calculation methods used data base of maximum rain flood runoff on 93 hydrological stations and posts of the State Hydrometeorological network within the territory of the Ukrainian Carpathians. All components of the calculating scheme had determined using statistical analysis and spatial generalization, accuracy of methods is at the level of accuracy of the initial information, and the method itself is recommended for practical use.

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ANALYSIS OF RELATIONSHIP BETWEEN DROUGHT AND CULTIVATION OF FIELD CROPS IN THE PANNONIAN BASIN

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Meteorological conditions can be considered as system of terms and conditions and system of affecting factors for crop production at the same time; that is why the position of agriculture is influenced in several ways by climatic variability. The plants generally can be adapted effectively to the most frequently occurring values of the environmental factors which are around the average. Extreme values of meteorological elements can cause serious anomalies/damages of life processes of crops. Meteorological extremes are projected to become more frequent and more intense during the next decades all over the world and thus in the Pannonian Basin, which can be a serious challenge for agriculture, and particularly for the cultivation of field crops. In our region the largest agricultural losses are caused by drought, therefore our studies are focused on the occurrence and impacts of this extreme event on crops on the base of an agroclimatological database built up in our department. The main chapters of the presentation are the following ones: evaluation of the criteria relating to the interpretation of the concept of drought, overview of the factors influencing drought, analysis of the impacts of drought on water supply and productivity of crops.

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CLIMATE CHANGE IMPACT IN SOME OF THE ROMANIAN PILOT BASINS

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The main objective of this study is to investigate the impact of climate changes observed during the second half of the 20th century and the beginning of the 21st century on the rivers flow regime for three Romanian pilot river basin areas: Barlad and Crisul Alb, located in the Eastern, respectively, Western parts of the country, and Dobrogea region, situated in the South-Eastern part of Romania, between the lower Danube River and the Black Sea. In order to identify the length and the magnitude of the climate changes that have affected the studied areas, we have analyzed recorded data time series to detect changes and trends. Also, in order to identify different types of drought (moderate, severe and extreme) we have used three climatic and hydrological indices: the Standardized Precipitation Index (SPI), the Standardized Precipitation and Evapotranspiration Index (SPEI) and the Standardized Flow Index (SFI). From the meteorological point of view, the dry periods were identified based on the drought index that takes into account only precipitation (SPI) as well as on the one that takes into account both precipitation and mean air temperature (SPEI). To highlight the dry periods from the hydrological point of view we have used the Standardized Flow Index (SFI) for which we applied the procedure of the SPI for monthly mean discharge time series. The results we obtained show for all the three Romanian pilot river basin areas an increasing of occurence and frequency of hydrological drought events.

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GEOGRAPHICAL HIGHER EDUCATION IN ROMANIA AND ITS CONTRIBUTION IN HYDRO-METEOROLOGICAL TRAINING. CURRENT STATUS AND FUTURE CHALLENGES

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Air and water, as essential components of the environment, have a major importance for human society and the natural processes and because of that, they were the subject of several key disciplines within the Faculties of Geography. Knowing and understanding the particularities of air and water environments allow, on the one hand, more efficient use of them for society, and on the other hand, its protection against the related risks. Over time, thanks to rigorous knowledge and skills acquired during college by attendance the courses in meteorology-climatology and hydrology, many geographers have become good practitioners at specialized institutions in the country. This paper aims to show synthetically which is the contribution of the most important faculties of geography in Romania in training specialists in fields of hydrology and meteorology. Thus, the paper is focused on the three faculties of geography in the country which have developed teaching lines of Hydrology and Meteorology: Faculty of Geography at the University of Bucharest; Faculty of Geography at Babeş-Bolyai University of Cluj-Napoca, and Faculty of Geography and Geology at Alexandru Ioan Cuza University of Iaşi. In the three institutions, training in fields related to the components of the hydrological cycle and associated processes, as well as of the atmosphere have been developed in the three study cycles (Bachelor, Master and PhD). Each program of study includes numerous specialized subjects (compulsory and optional) performed as courses, practical classes, field applications, and professional practices in specialized companies. The research activities for the development of license, master, and doctoral dissertations/ thesis have an important role in the personal development (theoretical and practical) of students as future researchers and practitioners. Usually, they perform the research activities in specialized research centers, such as: the Management of Water Resources and Hydrological Risk and Research Laboratory Biometeorology - Climate at the University of Bucharest; Research Centre for Physical Geography, Soil Sciences and Natural Resources Sustainable Exploitation as well as in scientific research basis "Ion Gugiuman" and "Simion Mehedinti" (both of them located in Eastern Carpathians) at the University of Iaşi; Research Centre for Natural Hazards, Laboratory of Meteorology, Laboratory of Hydrology, and in Baru Mare practical application basis (located in Southern Carpathians) at Babes-Bolyai University of Cluj-Napoca. Some of those dissertations and theses are integrated into national and international research projects carried out in research centers. In the future, training students in the faculties of geography must meet the challenges induced by a changing environment, where the hydro-climatic processes have a major impact on society and on the natural components of the environment. Keywords: higher education, hydrology, meteorology, hydrological cycle, Geography, Romania

CONTRIBUTION OF PLANT BREEDING IN MITIGATING CLIMATE CHANGE

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Today, the huge global problem is climate changes which can have serious environmental, social, economic and political consequences for humanity. One of the biggest challenges is how to find proper measures for adaptation and mitigation of the effects of climate change. Agricultural production is the sector most vulnerable to climate changes and biodiversity due to direct dependence on the weather conditions. Agriculture is at the same time the cause of climate changes and the most sensitive sector according to the numerous predictions which will suffer the worst damage from the effects of climate changes. Therefore, in all aspects of agricultural production numerous activities are undertaken in order to mitigate the negative impacts of climate change on the production of plant crops. The concept of agricultural production adapted to climate change should be developed. One of the most negative consequences of climatic conditions on crop production, primarily caused by prolonged periods of drought, in the Pannonian agro-ecological area are low yields, high production costs and loss of biodiversity. Therefore, nowadays is one of the biggest challenges for plant breeders how to create new varieties/hybrids that will ensure stable and high yields with good quality in different environmental conditions and how to preserve and use autochthonous genetic resources that are closely linked with adaptability to abiotic stresses. In breeding programs of agricultural plants numerous studies have been focused on the development of new varieties/hybrids tolerant to various environmental stresses (drought, low temperature, salinity and acidity of the soil, etc.) using classical and modern biotechnological methods (identification of quantitative trait loci (QTLs) associated with tolerance to various environmental stresses, marker assisted selection (MAS), the collection and characterization of autochthonous genetic resources (local populations, ecotypes, landraces, wild relatives, genetically variable plant germplasm), the development of varieties/hybrids with earlier flowering, the study of the physiological mechanisms of plant to stress in order to increases their nitrogen and water use efficiency (WUE, NUE), creating varieties/hybrids tolerant to lower concentration of N-nutrients in the soil. Continuous implementation of field testing of the most important agronomic traits of crops (yield and quality) in a series of comparative experiments on a number of locations along with the continuous monitoring of climatic conditions is an essential activity of plant breeding programs. Plant breeding plays an important and irreplaceable role in mitigating of the effects of climate changes and is one of the key scientific disciplines for coping with the new climatic challenges.

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INFLUENCE OF CLIMATE CHANGES ON PLANT DISEASES IN CROATIA

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Climate change and extreme weather events have direct influence on plant pathogens and plant diseases. Many reviews of the literature on plant diseases and climate change have been published (West et al. 2015, Pautasso et al. 2012, Alexander and Lee, 2010) They include effects of climate change on plant pathosystems and predicting scenarios for target pathogens and various plant disease control methods. One of climate change scenarios predicted for the Croatia is warmer winters and additional spring rainfall that may favor survival and growth of fungal pathogens. Fusarium head blight (FHB) is the most devastating disease of wheat. Fusarium graminearum (Giberella zeae) is the most common causal agent of FHB on a worldwide scale and cause considerable yield and quality losses. Research on Fusarium species in Croatia are constantly in focus of our working group. Nine Fusarium species and Microdohium nivale were identified from 1169 isolates of wheat plants in Croatia (Ćosić et al. 2004). The most dominant species from all parts of wheat was F. graminearum. Nine Fusarium species were isolated from residues of wheat during an eleven-year period (1996-2006) from eleven locations in eastern Croatia where F. graminearum was dominant species (Ćosić et al. 2008). Environmental conditions have a great influence on Fusarium infection of wheat grains, especially if temperature and rainfall are high during heading and flowering periods (Doohan et al., 2003). Heavy rainfall splashes inoculum from the soil up the plant and onto the emerging wheat heads. According to Croatian Metrological and hydrological service, the annual precipitation amounts for the May (heading and flowering period) during last 6 years for Eastern Croatia show that these precipitation amounts were above the average (1961-1900). According to percentile ranks and classification ratings, precipitation amounts for May (2010-2015) for Eastern Croatia (where wheat production is dominant) have been described by the categories very wet and wet The highest risk index of FHB is in the presence of more rainy days during May in the climate change scenario. Example of influence of climate change and extreme weather events on diseases of sunflower in Croatia shows that warm and very dry weather during the end of July and August (2015, 2013, 2012 years) caused appearance of Macrophomina phaseolina in high percentage. Percentage of infected untreated plants with fungicides was 30, 28 and 48% in 2012, 2013 and 2015, respectively, while infection with this pathogen in previous year on the same location was sporadic.

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AGRICULTURAL PRODUCTION IN SOUTH-EASTERN EUROPE IN CHANGING CLIMATE CONDITIONS

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Climate change in Europe represents a great challenge for European agriculture. The present climatic trends indicate that the northern areas may primarily have a positive effect through increases in productivity; while in southern areas the disadvantages will predominate resulting in lower harvestable yields, higher inter-annual yield variability and reduction of agricultural areas. Extreme events require specific analysis, as they may lead to crop failure. In this study we aim to present ongoing activities in Monitoring Agricultural Resources (MARS) of the Joint Research Centre (JRC) with relation to the impact of climate change on crop yields, with spatial focus on the Pannonian basin. Analysis focuses on current changes in agro-meteorological parameters and looks into climate change signal as well. Several adaptation options are analysed, such as different irrigation strategies and change in the crop varieties.

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CLIMATE CHANGE AND EXTREME WEATHER EVENTS IN THE TRANSCARPATHIAN AREA OF UKRAINE

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The Transcarpathian area of Ukraine is a part of Pannonian basin. The essential climate change has been observed in the region over the past decades. This change occurred in the thermal and moisture regimes, wind intensity and frequency of extreme and hazardous weather phenomena. The study presents an estimated change in the yearly, monthly and seasonal average, maximum and minimum air temperature and precipitation for 50 years (1961-2010) and change the frequency and intensity of extreme and hazardous weather phenomena in modern climatic period (1981-2010) in theTranscarpathian region. The analysis showed significant increase in the average, maximum and especially minimum air temperature resulted in prolongation of warm period, vegetation season and increase of the number of hot days. At the same time the duration of cold period, the number and severity of frosty days in winter were decreased in the region. It was found that a significant increase of air temperature in the region has led to changes in rainfall patterns due to increased frequency of rain and decrease frequency of snow. It also led to an increased frequency of wet snow, sleet slush and rise of its diameter. The consequence of increasing temperatures in the warm period is the increasing instability of the atmosphere in the region. The analysis of CAPE confirmed this finding. These changes led to increase in frequency and intensity of heavy rains, hail, squalls, thunderstorms in the region. Analysis of hazard rains showed that the its number and intensity also increases, but rainy days, especially in summer decreased. Precipitation sums also decreased during this period, leading to an increase of aridity. The analysis of the wind regime showed that daily average and maximum wind speed in the region decrease, but the number of dangerous squalls grows. The article also presents projections of climate change performance and extreme weather conditions in the Transcarpathian region for the period 2021-2050 relatively modern climatic period. Analysis carried out according to the regional model REMO-ECHAM5, scenario A1B. These studies were conducted in the framework of the project «LOC-CLIM- ACT: Local action on the impact of climate change". This project is implemented in the framework of Hungary-Slovakia-Romania-Ukraine ENPI CBC Program. The project has been implemented by the Carpathian Development Institute from Košice and by project partners: FORZA “Agency for sustainable development of the Carpathian region” from Uzhgorod (Ukraine); State Administration of Rakhiv District (Ukraine) and NORRIA-North Hungarian Regional Innovation Agency from Miskolc (Hungary).

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HEAVY RAINFALL – METHODOLOGY TO ESTIMATE THE IDF CURVES FOR HUNGARY

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The impacts of climate change on society come forward mainly through extreme weather and climate events. The warming climate evokes increasing frequency of extreme precipitation in some region. In the Pannonian basin the lack of precipitation such as drought events and the frequency of heavy rainfall increased too. The heavy rainfall could trigger floods on the rivers and flash flood on the leats. Moreover rainfall is one the main drivers of soil erosion. Automatic stations replaced the ombrographs in many places in Hungary making the short term equidistant sampling possible particularly from the late 1990s. In the Hungarian Meteorological Service the amount of precipitation is stored in the meteorological database in every ten minutes. The precipitation sum derived for several time intervals which are usual for design purposes can be analysed with using the 10 minutes sum. This paper reports an examination of extreme large 10 minutes sum and further derived rainfall amounts for a few durations e.g. 20, 30 minutes, 1, 2 3 hours, 1, 2 and 3 days. The precipitation measurements from 1998 are examined to avoid the inhomogeneity caused by the change of the measuring practice from manual to automatic. The General Extreme Value Distribution is used to estimate the IDF curves in the period of 1998-2013. Design values for 10, 20, 50, 100, 200 and 500 return periods are presented in this study for several meteorological stations. A case study makes the paper complete.

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THE CHANGING ROLE OF THE POLAR JET IN REGIONAL WEATHER CONDITIONS IN THE PANNONIAN REGION

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According to the synoptic practice the polar jet stream substantially influences the daily weather conditions in the midlatitudes including the Pannonian region. For instance, weather anomalies detected in the winter and spring of 2012-2013 are assumed to be the consequences of the unusual characteristics of the polar jet. To evaluate this hypothesis, high level winds (including both speed and direction) are analyzed for the Pannonian basin for 30 years (1981-2010) on annual, seasonal, and monthly time scales, and examine whether any change can be detected in the recent decades. The detailed general statistical analysis is performed for wind speeds at 18 levels above 500 hPa pressure level over the region. The analysis includes a general description, extreme statistical analysis, complex trend and correlation analysis with the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO), and EOF analysis to explore the action centers of variability.

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THE ESTIMATIONS OF EXTREME RUNOFF CHARACTERISTICS BY REGCM DRIVEN HYDROLOGICAL MODEL

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Since extreme hydrological conditions (e.g. long-lasting droughts, large floods, intense flash floods, low and high runoff characteristics) often result in severe socio-economic impacts, it is essential to estimate future trends, which will serve as a basis to build appropriate adaptation strategies. To analyse the hydrological consequences of climate change, the DIWA (DIstributed WAtershed) hydrological model is driven by the RegCM4 regional climate model. DIWA, which is a physically-based, distributed model, considers several aspects, e.g. topography and its relevant derivatives (slope, aspect, local drain directions, etc.), characteristics of the streambed, land cover, three soil layers and their hydraulic properties, interception, snow accumulation and melt, infiltration, evaporation and transpiration, furthermore, surface and stream runoff. To run DIWA, meteorological time series of precipitation, minimum and average temperature are provided by the observation-based CARPATCLIM dataset (for calibration/validation) and RegCM4 simulations taking into account the new RCP scenarios (for prediction). The methodology of coupling the hydrological and climatological models is presented for a selected small catchment area within the Pannonian Basin. Results for several target regions can be used to provide recommendations for decision makers in order to mitigate climate change induced hydrological hazards.

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STUDYING THE EFFECT OF URBAN ENVIRONMENT DURING HEAT WAVES WITH THE WRF MODEL - A BUDAPEST CASE STUDY

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The artificial surface covers of cities significantly modify the surface energy exchange processes through modification of naturally covered lands resulting in altered local wind and temperature patterns mainly because of the presence of buildings. The increased temperature in the central built-up areas and the cooler surrounding of the cities lead to the urban heat island phenomenon, which is widely studied both with observations and numerical models. The Weather Research and Forecasting (WRF) mesoscale model coupled to multilayer urban canopy parameterisation is used to investigate this phenomenon for Budapest and its surroundings. Before starting the simulations, the default surface characteristics of WRF are improved using independent, reliable databases (i.e. CORINE and OpenStreetMap). An intense heat wave (summer 2015) is analyzed using GFS (Global Forecast System) outputs to derive the initial meteorological fields. In order to keep the stability of the simulations, downscaling is carried out using gradually smaller domains embedded to each other; three embedded target areas have been determined for this modeling study, the 15 000 km2 large external area covers the whole Pannonian region with 10 km horizontal resolution, whereas the 7200 km2 large innermost domain covers Budapest and its surroundings with 1 km grid resolution.

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ANALYSIS OF PRESISTENT COLD AIR POOLS OVER THE PANNONIAN BASIN

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Persistent cold air pool (PCAP) is a winter-time, anticyclone-related weather event over a relatively large basin. During PCAP the air is colder near the surface than aloft resulting in inversion near the surface. As the cold air cools down, relative humidity increases and fog forms. PCAP usually appears when an anticyclone builds up after a cold front passed over the basin, and it is usually destructed by a coming strong cold front of another midlatitude cyclone. PCAP may result in different socio-economic hazards: (1) Temperature inversion in the surface layers together with weak wind may lead to severe air pollution causing human health problems. (2) Fog and/or smog during chilly weather conditions often results in freezing rain. Both fog and freezing rain can disturb transportation and electricity supply. Unfortunately, numerical weather prediction models have difficulties to predict PCAP formation and destruction, partially because of the lack of objective formula-like definition. However, according to some recommendations from the synoptic literature, the shallow convective potential energy (SCPE) can be used to mathematically describe PCAP. In this study, ERA-Interim reanalysis datasets are used to examine PCAP over the Pannonian Basin. The statistical analysis includes the evaluation of the length and intensity of PCAP periods.

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ASSESSING THE POTENTIAL OF EURO-CORDEX REGIONAL CLIMATE MODELS IN REPRODUCING EXTREME PRECIPITATION OVER ROMANIA

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EURO-CORDEX is the European branch of the international CORDEX initiative that aims to provide improved regional climate change projections for Europe. The main objective of this paper is to document the performance of the individual models in reproducing the variability of precipitation extremes in Romania. Five EURO-CORDEX regional climate models (RCMs) ensemble are analyzed and inter-compared: SMHI.RCA4-CNRM.CM5, KNMI.RACMO22E-EC.EARTH, DMI.HIRHAM5-EC.EARTH, CLMCom.CCLM-HadGEM2.ES and MPI.CSC-REMO2009. A high-resolution daily precipitation gridded data set was used as observational reference (CLIMHYDEX dataset). The comparison between RCM outputs and observed grid point values has been made by calculating three precipitation indices, recommended by the Expert Team on Climate Change Detection Indices, for the 1976-2005 period, namely: the annual count of days when precipitation ≥10mm; the annual maximum 5-day precipitation and R95P%, the precipitation fraction of annual total precipitation due to daily precipitation > 95th percentile. The RCMs generally simulate the main features of the precipitation extreme variability over Romania, but some deficiencies in reproducing of their regional characteristics were found: (1) overestimation of the mean state and variability, especially over the extra-Carpathian regions; (2) overestimation of the orographic effect by all models. This work has been realized within the research project "Changes in climate extremes and associated impact in hydrological events in Romania" (CLIMHYDEX), code PN II-ID-2011-2-0073, financed by the Romanian Executive Agency for Higher Education Research, Development and Innovation Funding (UEFISCDI).

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LOCAL CLIMATE RESPONSES IN THE DANUBE RIVER BASIN UNDER GLOBAL WARMING

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The goal of this study is the assessment of the future evolution of monthly temperature and precipitation and their influences exerted on drought and extreme precipitation episodes occurring in the Danube basin. We have used recent results of experiments based on 6 regional and 3 global climate models under the Representative Concentration Pathway (RCPs) scenarios (RCP 4.5 and RCP 8.5), which have been made accessible thanks to the EURO-CORDEX initiative. The impact of climate change on drought and extreme precipitation is assessed with the Palmer Drought Severity Index (PDSI) and associated components. Decreases in monthly precipitation amount and increases in potential evaporation have been identified as causes for the summer time drying, which is similar to the results for the mid-latitudes identified in the CMIP 3 model results. On the other hand, precipitation intensity increases in the area of interest under climate change, with largest magnitude in mountain regions.

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