PROJECT RESULTS
SCIENCE

Title: Serbian-Austrian-Italian (SAI) partnership Forcing Excellence in ecosystem research

Acronym: SERBIA FOR EXCELL

Grant number: 691998

Coordinator: Prof dr Branislava Lalic

Coordinator institution: Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

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End date: 31.12.2018

The aim of the SERBIA FOR EXCELL is the upgrade of knowledge, skills and social capacity of PFNS in the field of environmental sciences, with special focus on agrometeorology and related ecosystem sciences (such as plant physiology, crop management).

The main tool for reaching that aim is establishment of the AgMnet+ research network at PFNS in collaboration with leading international research institutions BOKU and UNIFI. As a strategy to improve S&T capacities of PFNS, AgMnet+ is introducing the concepts of small study groups of PFNS, BOKU and UNIFI students and joint study teaching material in English and native languages. BOKU and UNIFI partners are implementing goal-driven measurement, modelling training and project writing in the selected research fields for AgMnet+ members. Intensive exchange of short term scientific visits, guest lectures and students visits among partner institutions are contributing to improve eligibility of AgMnet+ members for participation on EU projects, increased number of papers in peer-review journals and increased citation.

Strategic partnership with BOKU and UNIFI, initiated by this project is significantly enhancing the research and innovations capacities of PFNS and upgrading the knowledge and skills of both of its students and researchers.

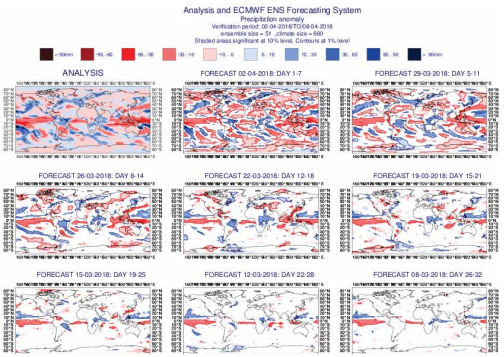
CONFERENCE PAPERS

Testing efficacy of monthly forecast application in agrometeorology: Winter wheat phenology dynamic

IOP 2018

Lalic, B., Jankovic, D., Dekic, L., Eitzinger, J., Sremac, A. F.

Abstract: Objective of this study is to test efficacy of monthly forecast in predicting phenology dynamics of different winter wheat varieties, using phenological model developed by Forecasting and Warning Service of Serbia in plant protection. Historical monthly forecast for four months was assimilated from ECMWF MARS archive for 50 ensemble members and control run. Impact of different agroecological conditions and tested by using observed and forecasted data for two locations - Serbia and Austria.

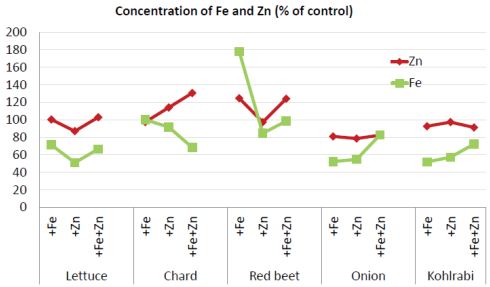


Exploring possibilities to fortify hydroponically grown baby vegetables with Fe and Zn

ICA 2018

Maksimović, I., Orlandini, S., Putnik-Delić, M. and Dalla Marta, A.

Abstract: In order to screen 5 vegetable species (chard, onion, red beet, kohlrabi and lettuce) with respect to their reactions to increased supply of Fe and Zn, an experiment was set up under semi-controlled conditions. Treatments included HS with doubled concentration of Fe, doubled concentration of Zn and doubled concentrations of Fe and Zn. Concentration of both Fe and Zn increased only in red beets and of Zn in chard. All three treatments increased biomass production only in kohlrabi.



Response of coriander (*Coriandrum sativum* L.) to low concentrations of NaCl

ICA 2018

Putnik-Delić M., Orlandini S., Dalla Marta A., Maksimović I., Daničić M. , Maričković I. and

Marjanović-Jeromela A.

Abstract: Coriander (*Coriandrum sativum*L.) is rich in essential oils, proteins, vitamin C and organic acids. It is widely used spice plant, but it is also well known for its medicinal features. Because salinity may change biochemical properties of plant tissues, the aim of this experiment was to explore the effect of low concentration of NaCl (which can often be found in irrigation waters) on biomass production and some biochemical parameters.

The WRF-ARW application in predicting meteorological conditions for Downy mildew (Plasmopara viticola) appearance of wine grape

EMS 2016

Firanj Sremac, A., Lalic, B. and Jankovic D.

Abstract: Objective of this study is to test the efficiency of the latest-generation numerical weather prediction model Weather Research and Forecasting Model with Advanced Research core (WRF-ARW) in predicting appearance of the downy mildew (Plasmopara viticola) in wine grape. Obtained results indicate great potential in using the short range numerical weather prediction in predicting meteorological conditions for downy mildew appearance in wine grape.

Probabilistic forecast of major arable crops in Serbia and Austria

EMS 2017

Firanj Sremac, A., Lalić, B., Perišić, D., Eitzinger, J., Stričević, R., Thaler, S., Maksimović, I., Daničić, M., Dekić, Lj.

Abstract: Probabilistic forecast of crop production is based on the ensemble of crop model output estimates (CMO). In this study data from two locations, one in Serbia and one in Austria were used for the run of crop model with meteorological ensemble data as input files. Meteorological data in the form of seasonal forecasts was collected yearly during 2006-2014 period and were assimilated from the European Centre for Medium-range Weather Forecast (ECMWF) and the Meteorological Archival and Retrieval System (MARS).

Interannual and seasonal variation of momentum exchange at a midlatitude mixed deciduous forest

EMS 2017

Firanj Sremac, A., Lalić, B., Fitzjarrald, D.R.

Abstract: Seasonal variation of leaf state affects momentum exchange between forest and the atmosphere. Sampling of relevant variables yielded half-hourly estimates of turbulent fluxes above and below the canopy of a red oak forest at Harvard Forest (Massachusetts, USA) during 2002-2011 period. These fluxes are used to assess seasonal and daily variation of momentum flux above forest, within and below the forest crown.

The role of soil organic matter on greenhouse gas emissions from different fertilizers

XLVI ISA and XX IAA

Verdi, L., Napoli, M., Mancini, M., Ljubojević, M., Dalla Marta, A. and Orlandini, S.

Abstract: In the present experiment, we evaluated the role of soil organic matter on the emissions of greenhouse gasses after the application of different fertilizers as liquid fraction of digestate from pig slurries, compost from organic fraction of municipal solid wastes, and urea on bare soil in order to avoid the influence of the crop. The experiment was performed on twenty-four bare soil pots with two levels of organic matter. Emissions were directly monitored through the use of a static chamber system and a portable gas analyser. Results show that soil organic matter as well as the composition of the fertilizers affect greenhouse gasses emissions.

Concentration of Fe and Zn in field grown pepper in different fertilization schemes

IPNC2017

Maksimović I., Putnik-Delić M., Eitzinger, J., Ilin, Ž. and Adamović, B.

Abstract: Concentration of Fe and Zn are important features of fruits, including pepper. Field experiment was set in order to assess the effect of different fertilization schemes (calculated on the basis of nitrogen input) and mulching on the concentration of Fe and Zn in fruits of two pepper cultivars. Mulching significantly increased concentration of Zn and reduced concentration of Fe in pepper fruits under applied fertilization schemes. There are significant differences between two pepper cultivars (Anita and Amfora) with respect to the concentration of Fe and Zn in fruits.

Fertilization effects on quality of cabbage produced in the greenhouse

IPNC2017

Putnik-Delić M., Maksimović I., Dalla Marta, A., Mirosavljević, M., Ilin, Ž. and Adamović, B.

Abstract: The aim of this research was to determine the effect of different fertilizers on quality of cabbage-heads produced in the greenhouse. Cabbage chemical composition significantly changes depending on the applied fertilizer. Fertilization with beef and pig manure with or without added NPK increased concentrations of nitrate, phosphorus and potassium in relation to the control, while the nitrogen content decreased using the same fertilizers.

Seasonal prediction of agroclimatic indices in Serbia and Austria

EMS 2018

Firanj Sremac, A., Lalić, B., Eitzinger, J., Ljubojević, M., Balaž, G., Krstić, Đ., Jaćimović, G., Daničić, M.

Abstract: Extreme weather events, like drought and heat waves, their duration and intensity are difficult to predict since they usually depend on large specter of environmental factors. Seasonal weather forecast (SWF) is therefore a powerful tool in assessing timing and effect of adverse weather conditions for crops. SWF is composed of ensembles of individual forecasts coupled to an ocean model and post-processed products of average conditions with the associated uncertainty. The efficiency of the SWF in adverse weather conditions prediction was expressed by comparing the indices calculated with observations and ensembles of SWF for two locations.

Gap filling in weather data time series - air temperature

EMS 2018

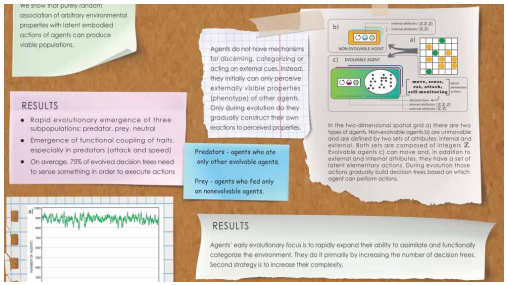
Lompar, M., Dekić, Lj. and Lalić, B.

Abstract: Data gaps are common problem of operational automated weather station (AWS) networks. Two procedures for gap filling were tested: 1) missing data are replaced with ERA5 data from nearest grid point and 2) debias procedure, based on data measured on AWS of interest, was applied on ERA5 data from nearest grid point. Both procedures are run for different duration of data gaps and different locations over the period of interest (1.3.-31.8.). Results were compared by comparison of RMSE obtained using ERA5-only and ERA5-debiased air temperature data series.

Making sense of nonsense: Evolutionary Emergence of Perceptual Assimilation of Environment in Agent Based System

ALIFE 2018

Balaž, I. and Schneider-Kitamura, E.



Abstract: The abilities of organisms to discern, categorize and act on external cues are very sophisticated and are based on a number of underlying processes. To investigate the development of these abilities, we designed a new evolutionary agent based system where agents start with no executable functions or with the inherent ability to recognize other elements in their environment. Our results show that in s^+ setting, the agent's early evolutionary focus is to, as soon as possible, expand their ability to perceptively assimilate environment and to functionally categorize environment by developing a variety of adaptive responses to newly assimilated environmental properties.

Modelling physical processes affecting atmosphere – living organism interaction

IBSC 2018

Lalić, B., Firanj Sremac, A., Dekić, Lj., Eitzinger, J., Petrić, M., Petrić, D., Pajović, I., Ljubojević, M.

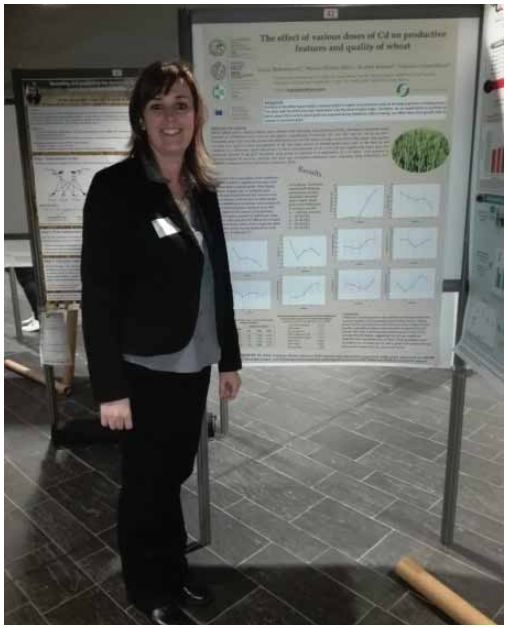
Abstract: The main goal of this study is to broden our understanding of processes describing biosphereatmosphere interaction and its application in agriculture. Achievement of this goal is based on full coupling of experiment, theory, modeling and practice. Study experimental base consists of atmospheric and biological measurements. Atmospheric data sources are: a) ECMWF ERA5 reanalysis and weather forecast, b) weather database of Forecasting and Warning Service of Serbia in plant protection (PIS) (Serbia), c) ZAMG database (Vienna, Austria), d) Harvard forest database (Harvard, MA, USA) and e) Jungle research group experiments (SUNY, Albany, USA). Biological observations and measurements are classified according to organism of interest on: a) mosquito surveillance conducted by PFNS (Novi Sad, Serbia) and Biotechnical Faculty (Podgorica, Montenegro); b) plant and harmful organism monitoring within PIS (Serbia) network, c) Harvard forest data base (Harvard, MA, USA), d) monitoring of fruit trees development performed by PFNS (Novi Sad, Serbia) and e) COMBIRISK data bank (a research project of the Austrian Climate and Energy Fund).

The effect of various doses of Cd on productive features and quality of wheat

The SFECOLOGIE 2018

Maksimović, I., Putnik-Delić, M., Kastori, R. and Momcilović, V.

Abstract: Similarly to the other heavy metals, cadmium (Cd) is in higher concentrations toxic to all living organisms, including plants. Therefore, experiments were set to examine to which extent Cd to which wheat grain was exposed during imbibition, can affect later plant growth and Cd content in harvested grain. Plant height, number of spikes per m2 and grain yield significantly declined with the increase in Cd concentration in the solution in which grains were imbibed prior to sowing. Length of spikes, number of spiklets per spike, mass of grains per spike, harvest index and mass of 1000 grains changed to a much lesser extent.



The Changes in accumulation of essential macronutrients during vegetative growth of rapeseed exposed to NaCl

The SFECOLOGIE 2018

Putnik-Delić, M., Maksimović, I., Daničić, M. and Kastori, R

Abstract: Stress caused by increased salt concentrations affects plant metabolism and the final outcome of plant production in many ways. To assess the extent to which the steady presence of sodium chloride in relatively low concentration affect plants, an experiment was set with rapeseed. Overall, NaCl affected to a higher extent, concentrations of K and Ca, than N and P. Even though applied concentrations of NaCl were relatively low, they induced significant changes.

The establishment of alfalfa with field pea-oat mixture as a cover crop

2nd World Alfaalfa Congress

Krstic, Dj., Vujic, S. , Firanj Sremac, A., Danicic, M., Orlandini, S.

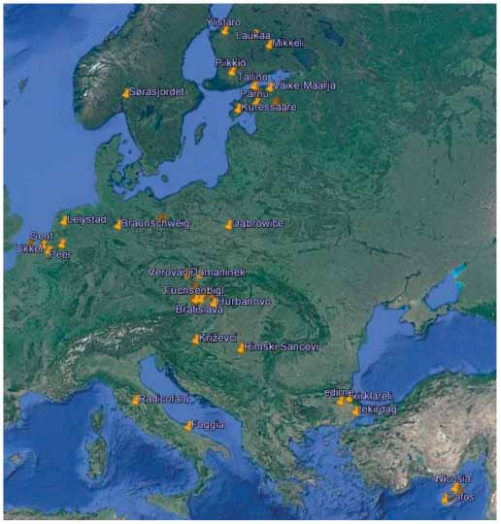
Abstract: The aim of this study was to determine the suitability of field pea and their mixture with oat as a companion crop for alfalfa establishment and weeds control. The interaction year and treatment was not significant. Based on a two-year average, dry matter yield in the first cut ranged from 1.69 t ha^{-1} in pure alfalfa stand to 6.30 t ha^{-1} in intercropping alfalfa and 100% oat and the yield decreased with reduced oat proportion in the mixture. The lowest total yield in intercropping was recorded in the mixture of alfalfa and 100% pea and the highest in the mixture of alfalfa with 70%P+30%O. The total annual yield of alfalfa pure stand was significantly lower than other treatments (5.53 t ha^{-1}).

SCIENTIFIC JOURNALS

Variability in the Water Footprint of Arable Crop Production across European Regions

Water 2017, *9*(2), 93; doi:10.3390/w9020093

Anne Gobin,Kurt Christian Kersebaum, Josef Eitzinger, Miroslav Trnka, Petr Hlavinka, Jozef Takáč, Joop Kroes, Domenico Ventrella, Anna Dalla Marta,Johannes Deelstra,Branislava Lalić, Pavol Nejedlik, Simone Orlandini, Pirjo Peltonen-Sainio, Ari Rajala, Triin Saue, Levent Şaylan, Ruzica Stričevic, Višnja Vučetić and Christos Zoumides



Abstract: Crop growth and yield are affected by water use during the season: the green water footprint (WF) accounts for rain water, the blue WF for irrigation and the grey WF for diluting agri-chemicals. In this research calibrated crop yield for FAO's water balance model "Aquacrop" at field level was tested. Samples included weather, soil and crop inputs for 45 locations for the period 1992–2012.

Winter cover crops as green manure in a temperate region: the effect on nitrogen budget and yield of silage maize

Crop and Pasture Science, *68*(10–11), 1060-1069. http://dx.doi.org/10.1071/CP17070

Ćupina, B., Vujić, S., Krstić, D., Radanović, Z., Čabilovski, R., Manojlović, M. and Latković, D.

Abstract: Winter cover crops may provide different environmental benefits in agricultural systems. The aim of this study was to determine the effect of cover crops used as green manure on the soil nitrogen (N) budget and yield of silage maize (Zea mays L.). Results show that the ability of cover crops to provide benefit for a subsequent crop is highly related to weather conditions, mainly precipitation.

Seasonal forecasting of green water components and crop yields of winter wheat in Serbia and Austria

The Journal of Agricultural science https://doi.org/10.1017/S0021859617000788

Lalić, B., Firanj Sremac, A., Dekić, Lj, Eitzinger, J. and Perišić, D.

Abstract: A probabilistic crop forecast based on ensembles of crop model output (CMO) estimates offers a myriad of possible realizations and probabilistic forecasts of green water components (precipitation and evapotranspiration), crop yields and green water footprints (GWFs) on monthly or seasonal scales. The results indicate that the use of seasonal weather forecasting in agriculture and its applications for probabilistic crop forecasting can optimize field operations (e.g., soil cultivation, plant protection, fertilizing, irrigation) and takes advantage of the predictions of crop development and yield a few weeks or months in advance.

Seasonal forecasting of green water components and crop yield of summer crops in Serbia and Austria

The Journal of Agricultural science https://doi.org/10.1017/S0021859618000047

Lalić, B., Firanj Sremac, A., Eitzinger, J., Stričević, R., Thaler, S., Maksimović, I., Daničić, M., Perišić, D. and Dekić, Lj.

Abstract: A probabilistic crop forecast based on ensembles of crop model output estimates, presented here, offers an ensemble of possible realizations and probabilistic forecasts of green water components, crop yield and green water footprints (WFs) on seasonal scales for selected summer crops. Best results were obtained for ensemble forecast for yield, ET, water productivity and green WF for sunflower in Novi Sad (Serbia) and maize in Groß-Enzersdorf (Austria) – average root mean square error (2006–2014) was <10% of observation-based values of selected variables.

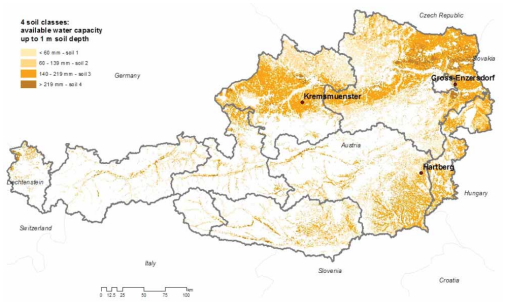
Greenhouse gas and ammonia emissions from soil: the effect of organic matter and fertilization method

Italian Journal of Agronomy https://doi.org/10.4081/ija.2018.1124

Verdi, L., Mancini, M., Ljubojević, M., Orlandini, S. and Dalla Marta, A.

Abstract: Greenhouse gas emissions (GHGs) into the atmosphere derived from the use of fertilizers is a serious issue for the sustainability of agricultural systems, also considering that the growing global demand for food requires an increasingly productive agriculture. In the present experiment, the combined effect of soil organic matter (SOM) and fertilization method on the emissions of GHGs and ammonia (NH3) was investigated. Results show that soil organic matter as well as the composition of the fertilizers affect greenhouse gasses emissions. The obtained results show that the content of organic matter in soils plays a key role on the emissions of GHGs, generally enhancing the levels of gas emissions.

Effects of Different Spatial Precipitation Input Data on Crop Model Outputs under a Central European Climate



Atmosphere 2018, 9, 290. https://doi.org/10.3390/atmos9080290

Thaler, S., Brocca, L., Ciabatta, L., Eitzinger, J., Hahn, S. and Wagner, W.

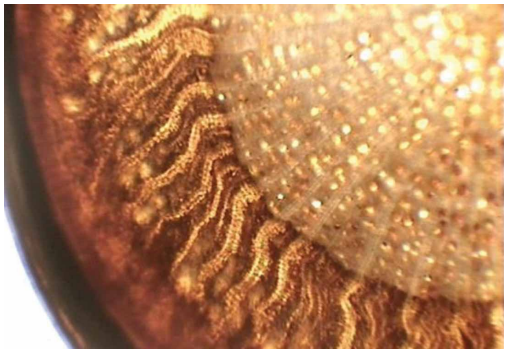
Abstract: Crop simulation models, which are mainly being utilized as tools to assess the consequences of a changing climate and different management strategies on crop production at the field scale, are increasingly being used in a distributed model at the regional scale. In the current study, the crop growth model Decision Support System for Agrotechnology Transfer (DSSAT) was used to evaluate five gridded precipitation input data at three locations in Austria. The highest variance was obtained for the driest area with light-textured soils; TMPA and two soil moisture-based products showed very good results in the more humid areas. The poorest performances at all three locations and for both crops were found with the CMORPH input data.

Environmentally-Related Cherry Root Cambial Plasticity

Atmosphere 2018, 9, 358. doi:10.3390/atmos9090358

Ljubojević, M., Maksimović, I., Lalić, B., Dekić, L., Narandžić, T., Magazin, N., Dulić, J., Miodragović, M., Barać, G. and Ognjanov, V.

Abstract: The general aim of this research was to determine whether the cherry root cambium possesses similar water-stress adaptation abilities as the scion. Specifically, this study aimed to determine whether there is a shift in root xylem structure due to precipitation fluctuations and temperature increase during the growing season in two cherry species. Oblačinska sour cherry and European ground cherry roots were anatomically surveyed in detail, and correlated with meteorological conditions. Under environmental signals, both investigated species altered their radial root growth imprinting stops and starts in a cambial activity that resulted in the occurrence of intra-annual false growth rings, while conduit size seemed to be mainly genetically controlled.

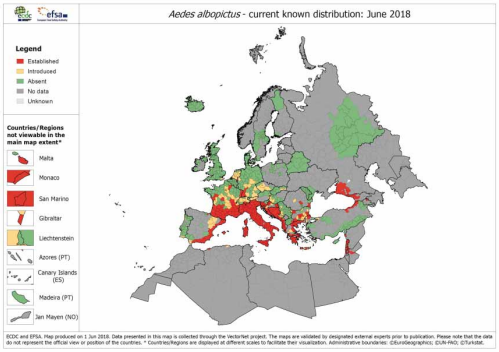


Expected Changes of Montenegrin Climate, Impact on the Establishment and Spread of the Asian Tiger Mosquito

Atmosphere 2018, 9, 453. doi: 10.3390/atmos9110453

Petrić, M., Lalić, B., Pajović, I., Micev, S., Đurđević, V. and Petrić, D.

Abstract: *Aedes albopictus* has become established in many parts of Europe since its introduction at the end of the 20th century. An analysis of the expected climate change and the related shift in Köppen zones for Montenegro and impact on the establishment of Ae. albopictus was conducted. The results point to a significant increase in suitability for the mosquito and a vertical shift to higher altitudes by the end of the century. This study provides a tool for prioritizing surveillance efforts (model-based surveillance), especially when resources are limited.

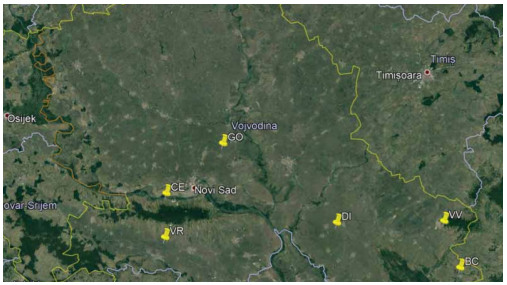


Toward a Weather-Based Forecasting System for Fire Blight and Downy Mildew

Atmosphere 2018, 9 (12), 484. https://doi.org/10.3390/atmos9120484

Firanj Sremac A., Lalić, B., Marčić, M and Dekić, Lj.

Abstract: The aim of this research is to present a weather-based forecasting system for apple fire blight (*Erwinia amylovora*) and downy mildew of grapevine (*Plasmopara viticola*) under Serbian agroecological conditions and test its efficacy. For disease modelling, we selected a biometeorological system for messages on the occurrence of diseases in fruits and vines (BAHUS) because it contains both diseases with well-known and tested algorithms. The results obtained encourage further development, with the goal of fully utilizing this weather-based forecasting system.

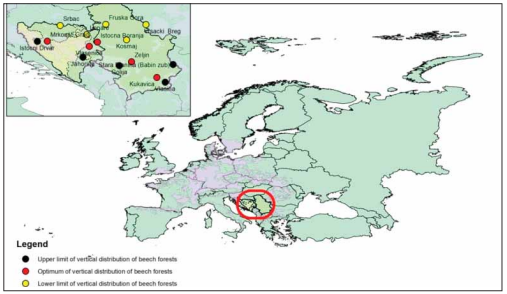


The Impact of Adverse Weather and Climate on the Width of European Beech (Fagus sylvatica L.) Tree Rings in Southeastern Europe

Atmosphere 2018, *9* (11), 451. https://doi.org/10.3390/atmos9110451

Stjepanović, S., Matović, B., Stojanović, D., Lalić, B., Levanič, T., Orlović, S. and Gutalj, M.

Abstract: The aim of this research was to explore the dynamics of tree diameter increments and the influence of extremely dry years on the width of tree rings. This study used dendro-chronological methods to analyze the growth and diameter increments of European beech trees at locations in Serbia and the Republic of Srpska. Long-term analyses indicate that dry conditions during a growing season can reduce tree-ring width, but a reduction in tree growth can be expected as a result of more than one season of unfavorable conditions.

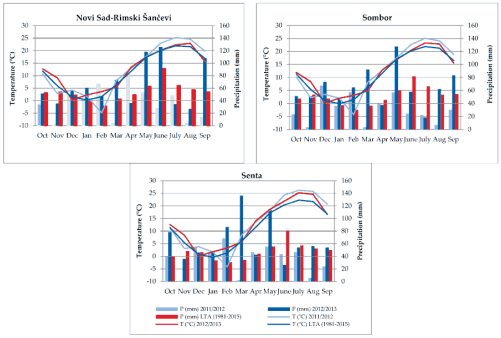


The Impact of Adverse Weather and Climate on the Width of European Beech (Fagus sylvatica L.) Tree Rings in Southeastern Europe

Atmosphere **2018**, *9*(12), 492; https://doi.org/10.3390/atmos9120492

Krstić, Đ., Vujić, S., Jaćimović, G., D' Ottavio, P., Radanović, Z., Erić, P. and Ćupina, B.

Abstract: Soil and water conservation benefits of cover crops have been hypothesized as a way to mitigate and adapt to changing climatic conditions, but they can also have detrimental effects if rainfall is limited. The objective was to quantify effects of winter cover crops on soil water storage and yield of silage maize under the agro-ecological conditions within Vojvodina Province in Serbia. This detrimental effect of cover crops on soil water balance was confirmed by correlations between soil water storage and maize silage yield.

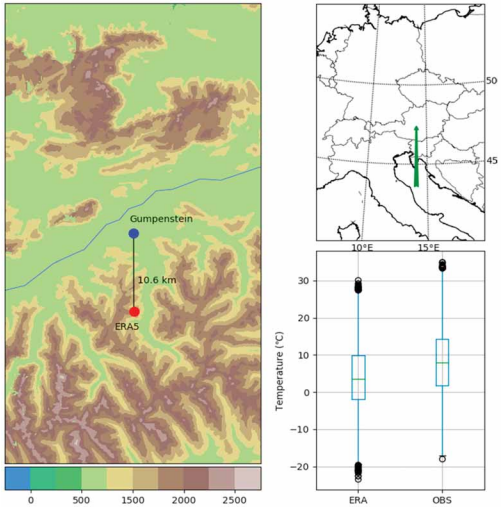


Filling Gaps in Hourly Air Temperature Data Using Debiased ERA5 Data

Atmosphere 2019, 10(1), 13; https://doi.org/10.3390/atmos10010013

Lompar, M., Lalić, B., Dekić, L. and Petrić, M.

Abstract: Missing data in hourly and daily temperature data series is a common problem in long-term data series and many observational networks. To support user communities, a technique for gap filling is developed based on the debiasing of ERA5 reanalysis data, the fifth generation of the ECMWF atmospheric reanalyses of the global climate. The debiasing procedure includes in situ measured temperature. The methodology is tested for different landscapes, latitudes, and altitudes, including tropical and midlatitudes. The study shows very low average RMSE for all gap lengths ranging from 1.1 °C (Montecristo, Italy) to 1.9 °C (Gumpenstein, Austria).



The Response of Spring Barley (Hordeum vulgare L.) to Climate Change in Northern Serbia

Atmosphere 2019, 10(1), 14; https://doi.org/10.3390/atmos10010014

Daničić, M., Zekić, V., Mirosavljević, M., Lalić, B., Putnik-Delić, M., Maksimović, I., Dalla Marta, A.

Abstract: The present study assessed the effect of projected climate change on the sowing time, onset, and duration of flowering, the duration of the growing season, and the grain yield of spring barley in Northern Serbia. An AquaCrop simulation covered two climate model integration periods (2001–2030 and 2071–2100) using a dual-step approach (with and without irrigation). The results showed that the projected features of barley production for the 2001–2030 period did not differ much from current practice in this region. On the contrary, for the 2071–2100 period, barley was expected to be sown earlier, to prolong its vegetation, and to shorten flowering's duration.

Serbia for Excell

The project SERBIA FOR EXCELL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691998.