Project No. 037005

CECILIA

Central and Eastern Europe Climate Change Impact and Vulnerability Assessment

Specific targeted research project

1.1.6.3.I.3.2: Climate change impacts in central-eastern Europe

Periodic activity report

Period covered: 1st June 2006 to May 31st 2007 **Date of preparation: 13th July 2007**

Start date of project: 1st June 2006 **Duration: 36 months**

Project coordinator name: **Tomáš Halenka**
Project coordinator organisation name: **Charles University**

Publishable Executive Summary

SIXTH FRAMEWORK PROGRAMME

SUB-PRIORITY 1.1.6.3

Global Change and Ecosystems

SPECIFIC TARGETED RESEARCH PROJECT

Project full title: **Central and Eastern Europe Climate Change Impact and VulnerabiLIty Assessment**
Project acronym: **CECILIA** Project website: **http://www.cecilia-eu.org**
Contract no.: **037005**
Priority thematic areas: 1.1.6.3.I.3.2 - Climate change impacts in central-eastern Europe
Duration of the project: **1 June 2006 – 31 May 2009**

List of Participants

Participant No.	Participant name	Participant short name	Country
1	Charles University, Prague	CUNI	Czech Republic
2	The Abdus Salam ICTP, Trieste	ICTP	Italy
3	Météo-France, Toulouse	CNRM	France
4	Danish Meteorological Institute, Copenhagen	DMI	Denmark
5	Aristotle University of Thessaloniki	AUTH	Greece
6	Czech Hydrometeorological Institute, Prague	CHMI	Czech Republic
7	Institute of Atmospheric Physics, Prague	IAP	Czech Republic
8	Swiss Federal Institute of Technology Zurich	ETH	Switzerland
9	University of Natural Resources and Applied Life Sciences, Vienna	BOKU	Austria
10	National Meteorological Administration, Bucharest	NMA	Romania
11	National Institute of Meteorology and Hydrology, Sofia	NIMH	Bulgaria
12	National Institute of Hydrology and Water Management, Bucharest	NIHWM	Romania
13	Hungarian Meteorological Service, Budapest	OMSZ	Hungary
14	Forest Research Institute, Zvolen	FRI	Slovakia
15	Warsaw University of Technology, Warsaw	WUT	Poland
17	Eötvös Loránd University, Budapest	ELU	Hungary

Total cost: **4,424,572 € (incl. estimated own resources of AC partners)**
Commission funding: **2,749,891 €**

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Project main goal

The main goal of CECILIA is to provide climate change impacts and vulnerability assessment in targeted areas of Central and Eastern Europe (CEE). This addresses directly the topic I.3.2 “Climate changes in central-eastern Europe” under research area 3.1.3 “Prediction of climatic change and its impacts” in part 3.1 concerning the “Impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks” within FP6 Sub-Priority Area “1.1.6.3 Global Change and Ecosystems”. Our objectives and work plan contribute to the scientific, technical and social and policy objectives of this topic area. We target our analysis on selected key areas of specific interest to the region. The floods and droughts which occurred in recent summers in the region highlight the importance of the hydrologic cycle and water management in Elbe and Danube river catchments in response to the occurrence of precipitation extremes. Impacts on agriculture and forestry affecting the economy of countries in the region will be studied as well. The 2003 heat wave demonstrated the importance of the health impacts of extreme conditions that could also lead to considerable changes in air quality, both regionally and in major urban centres.

The aim of the project is to assess the impact of climate change at the regional to local scale for CEE using very high resolution in order to capture the effects of the complex terrain of the region. This goal will be achieved mainly using very high resolution RCMs run locally for targeted areas. From the viewpoint of climate change scenario production two time slices are planned, for 2020-2050 and 2070-2100. Changes in weather patterns and extreme events are addressed within the project as they affect the important sectors for the economies and welfare of individual countries in the region. Uncertainties will be evaluated by comparing results with those from previous projects (PRUDENCE, ENSEMBLES). The selected applications of the CECILIA outputs are supposed toward water resources and management, agriculture, forestry, air quality and health. In addition, CECILIA will improve the access of CEE researchers to information and facilities for climate change research by providing an efficient use and access to the results of previous and ongoing EC projects which the proposed research will benefit greatly from. Thus, CECILIA will integrate world leading European expertise in regional climate modelling with high resolution impact studies to provide new policy relevant information on climate change and its interactions with society at the regional scale. It will also feed into adaptation and mitigation strategies in targeted areas.

Key issues

Emphasis is given to application of regional climate modelling studies at a resolution of 10 km for local impact studies in key sectors of the region. Very high resolution simulations over this region are necessary due to the presence of complex topography and land use features. Impacts on large urban and industrial areas modulated by topographical and land-use effects resolved at the 10 km are investigated. The high spatial and temporal resolution of national observational networks and of regional model experiments will feed into investigations of consequences for weather extremes in the region. Comparison with the results based on statistical downscaling will also be provided. Statistical downscaling methods for verification of the regional model results will be developed and applied, and assessments of their use in localization of model output for impact studies will be performed. The objectives will be achieved through the following tasks:

- *To collect, assess and make available for first local impact studies the scenarios and climate simulations produced in previous relevant projects where available. (WP1)*
- *To adapt and develop very high resolution RCMs for the region (10 km grid spacing) and perform regional time-slice nested runs driven by ERA40 data and by GCMs for selected GHG change scenarios. (WP2)*
- *To verify the model results, compare RCM and statistical downscaling results, analyze and develop the methods for verification, particularly at local scales, to provide the scenarios. (WP3)*
- *To estimate the effect of global climate change on extreme events in the region, including the assessment of the added value of high-resolution for the simulation of the relevant processes and feedbacks. To evaluate uncertainties in regional projections by comparing results from previous projects (WP4)*

- *To assess (using high resolution downscaling results) the impacts of climate change on the hydrological cycle and water resources over selected catchments; the effects of climate change on the Black Sea (WP5)*
- *To study (based on the high resolution downscaling results) the impacts of climate change on agriculture and forestry, carbon cycle and selected species (WP6)*
- *To study (based on the high resolution downscaling results) the impacts of climate change on health and air quality (photochemistry of air pollution, aerosols) (WP7)*

Expected achievements/impact

Although the broad response of global climate to increased greenhouse gas concentrations is well established, many unknowns remain in the regional details of projections of future climate change. Thus, the central internal objectives of CECILIA are to improve regional climate scenarios and their localization for climate impacts models, and comparing these results against the results of previous and ongoing projects to assess the added value of dynamical downscaling at very fine scales. The general aim of CECILIA is to improve Europe's ability to assess the consequences of global climate change at the local scale, and on this basis to assist to formulate more precise response strategies and more scientifically based negotiating positions. Such an effort will assist in the successful implementation of the FCCC (Framework Convention on Climate Change) and the Kyoto Protocol, for the negotiations in the post Kyoto process and in regulations to mitigate the possible consequences of climate change as concluded by IPCC. Very high resolution and better regional predictions are required to guide long term planning in sectors such as agriculture and energy.

Several key issues connected with climate change have become of interest in recent years, such as the occurrence of extremes or effects on air quality, with potentially severe impacts on the quality of life, health and safety. The occurrence of these extreme events, in some cases causing loss of human life and extensive damages or costs, is affected by the relation between extremes and climate change which can be better explored using high resolution climate modelling. Results will allow us to evaluate the vulnerability of different sectors in the regions. CECILIA will provide high resolution tools to help anticipate and ameliorate the adverse impacts of climate change on humans both at the individual and at the societal level. It will help to identify and exploit positive impacts. It will provide demonstrations of the use of these tools in important economic, environmental or social sectors where the impacts of climate change are likely to be felt. Results of simulations generated within the project are expected to be available for other interested institutes in Europe, with the possibility of use in national projects on climate change impacts over the targeted area.

Climate change represents a major factor affecting the global and European environments. Natural ecosystems will become stressed if climatic zones shift at a faster rate than the ecosystems can migrate. Changing availability of natural resources such as water supply may adversely affect the sustainability of European activites. A more stressed environment will be even more vulnerable to natural hazards. CECILIA with high resolution climate simulation can help anticipate and ameliorate the adverse impacts on the local environment and natural resources of the targeted regions. It can also provide mitigation information to reduce the hazards concerning these important factors. Concerning the environment, CECILIA, similarly as the EC project QUANTIFY, will provide a platform for reducing the gap between climate change and air quality sciences, putting together traditional aspects of climate change impacts and impacts on air quality.

This project brings very high resolution localization of climate change scenarios into the targeted areas of CEE, with the added value of climate scenarios produced locally. This will provide necessary policy relevant information concerning the local adaptation and/or mitigation measures. Moreover, it will provide know-how and tools which can be further used for the analysis of the climate change development and climate change impacts on different sectors of the society in the target region. With the emphasis on former Eastern Block countries the CECILIA project will provide new access and contacts for researchers from this area to the European research activities and thus help to bridge existing gaps. An important point of innovation consists in the fact that very high resolution climate information will allow application in integrated climate change impact studies, which will in turn provide for the first time necessary policy relevant information for decision makers and local authorities in the region.

Major achievements

In framework of a review of previous available results (PRUDENCE project) first estimates of climate change signal for targeted regions were publicised on the scientific meetings and presented to endusers (see Fig.1). More detailed analysis as well as the comparison with other results (IPCC 4AR model results) are under preparation for publication. For further high resolution simulations six regional climate models covering Czech Republic (two models), Hungary (two models), Romania and Bulgaria have been prepared for present day climate simulation as well as climate change scenarios. These models cover a relatively small domain, but possess a high horizontal resolution (10 km). This resolution is typical for meteorological forecast, but far from the classical resolution in regional climate modeling (50 km). This change has implied an adaptation of the models in order to deliver a reasonable climate for present conditions. Preparatory work has started defining the lists of variable of interest either for climate change signal analysis or impact studies, different kinds of impact models for selected sectors were developed or adapted for the high resolution in appropriate regions and calibrated if necessary.

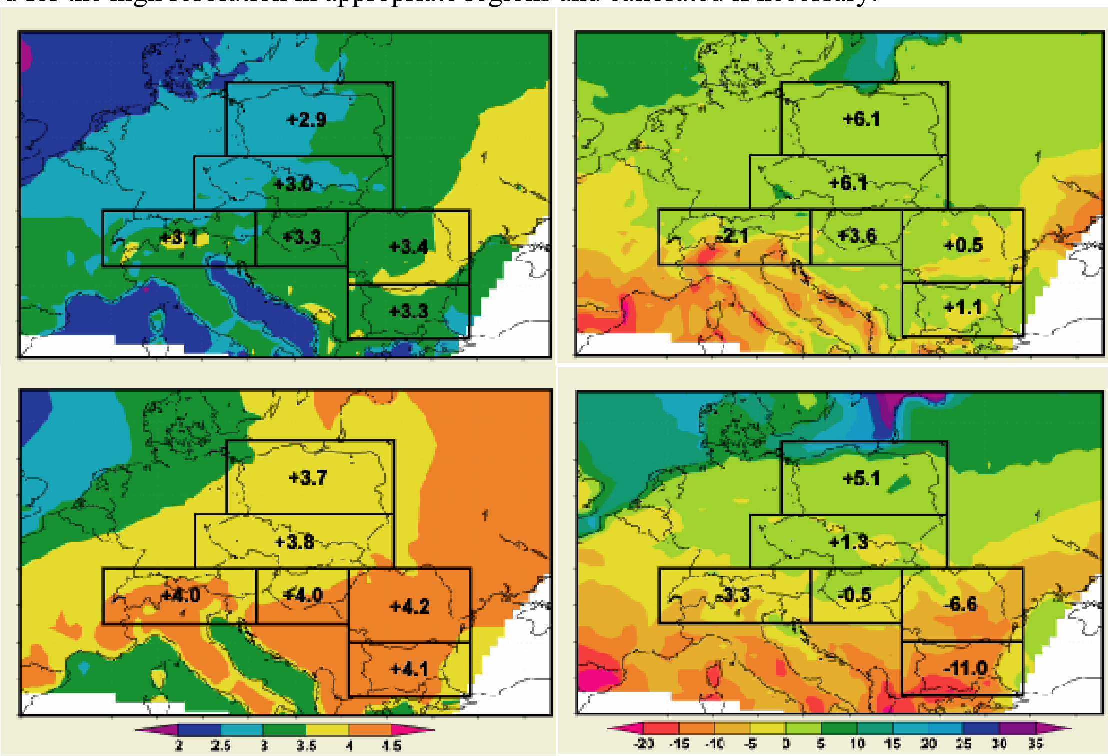

Figure 1. *Change of temperature (°C – left column) and precipitation (% - right column) in 2071-2100 relative to 1961-1990 in the CECILIA target areas for emission scenarios A2 (bottom panels) and B2 (upper panels).*

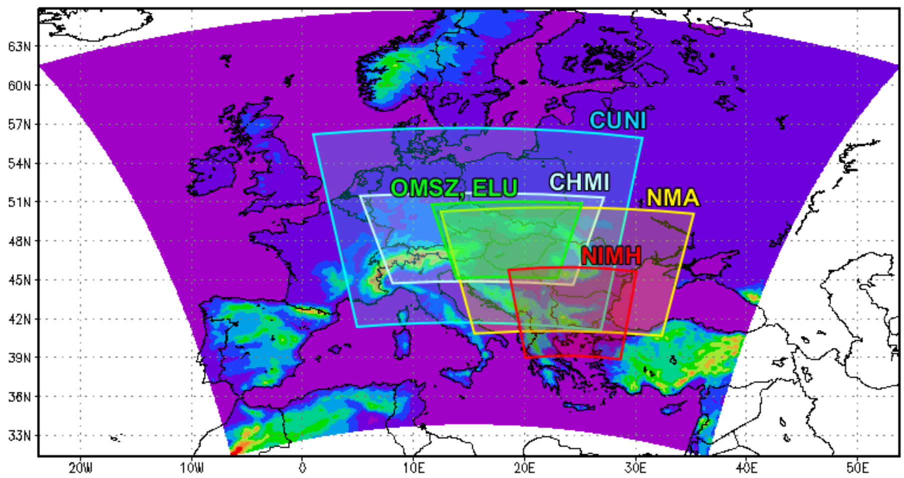

Figure 2. *Integration domains of individual partners in targeted regions.*

Section 1 Project objectives and major achievements during the reporting period

1.1 Project objectives, relation to state-of-the-art

1.1.1 Project main goal

The main goal of CECILIA is to provide climate change impacts and vulnerability assessment in targeted areas of Central and Eastern Europe (CEE). We target our analysis on selected key areas of specific interest to the region. The floods and droughts which occurred in recent summers in the region highlight the importance of the hydrologic cycle and water management in Elbe and Danube river catchments in response to the occurrence of precipitation extremes. Impacts on agriculture and forestry affecting the economy of countries in the region will be studied as well. The 2003 heat wave demonstrated the importance of the health impacts of extreme conditions that could also lead to considerable changes in air quality, both regionally and in major urban centres.

The aim of the project is to assess the impact of climate change at the regional to local scale for CEE using very high resolution simulations in order to capture the effects of the complex terrain of the region. This goal will be achieved mainly using very high resolution RCMs run locally for targeted areas. From the viewpoint of climate change scenario production two time slices are planned, for 2020-2050 and 2070-2100. Changes in weather patterns and extreme events are addressed within the project as they affect the important sectors for the economies and welfare of individual countries in the region. Uncertainties will be evaluated by comparing results with those from previous projects (PRUDENCE, ENSEMBLES). The selected applications of the CECILIA outputs are supposed toward water resources and management, agriculture, forestry, air quality and health. In addition, CECILIA will improve the access of CEE researchers to information and facilities for climate change research by providing an efficient use and access to the results of previous and ongoing EC projects which the proposed research will benefit greatly from, e.g.:

- "Modelling the Impact of Climate Extremes (MICE)"
- "Statistical and regional dynamical downscaling of extremes for European regions (STARDEX)".
- "Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects" (PRUDENCE)
- "ENSEMBLE-based Predictions of Climate Changes and their Impacts" (ENSEMBLES)
- "Quantifying the Climate Impact of Global and European Transport Systems" (QUANTIFY)

Thus, the project CECILIA will integrate world leading European expertise in regional climate modelling with high resolution impact studies to provide new policy relevant information on climate change and its interactions with society at the regional scale. It will also feed into adaptation and mitigation strategies in targeted areas.

1.1.2 Key issues

Emphasis is given to application of regional climate modelling studies at a resolution of 10 km for local impact studies in key sectors of the region. Very high resolution simulations over this region are necessary due to the presence of complex topography and land use features. Impacts on large urban and industrial areas modulated by topographical and land-use effects resolved at the 10 km are investigated. The high spatial and temporal resolution of national observational networks and of regional model experiments will feed into investigations of consequences for weather extremes in the region. Comparison with the results based on statistical downscaling will also be provided. Statistical downscaling methods for verification of the regional model results will be developed and applied, and assessments of their use in localization of model output for impact studies will be performed. The objectives will be achieved through the following tasks:

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- *To study (based on the high resolution downscaling results) the impacts of climate change on agriculture and forestry, carbon cycle and selected species (WP6)*
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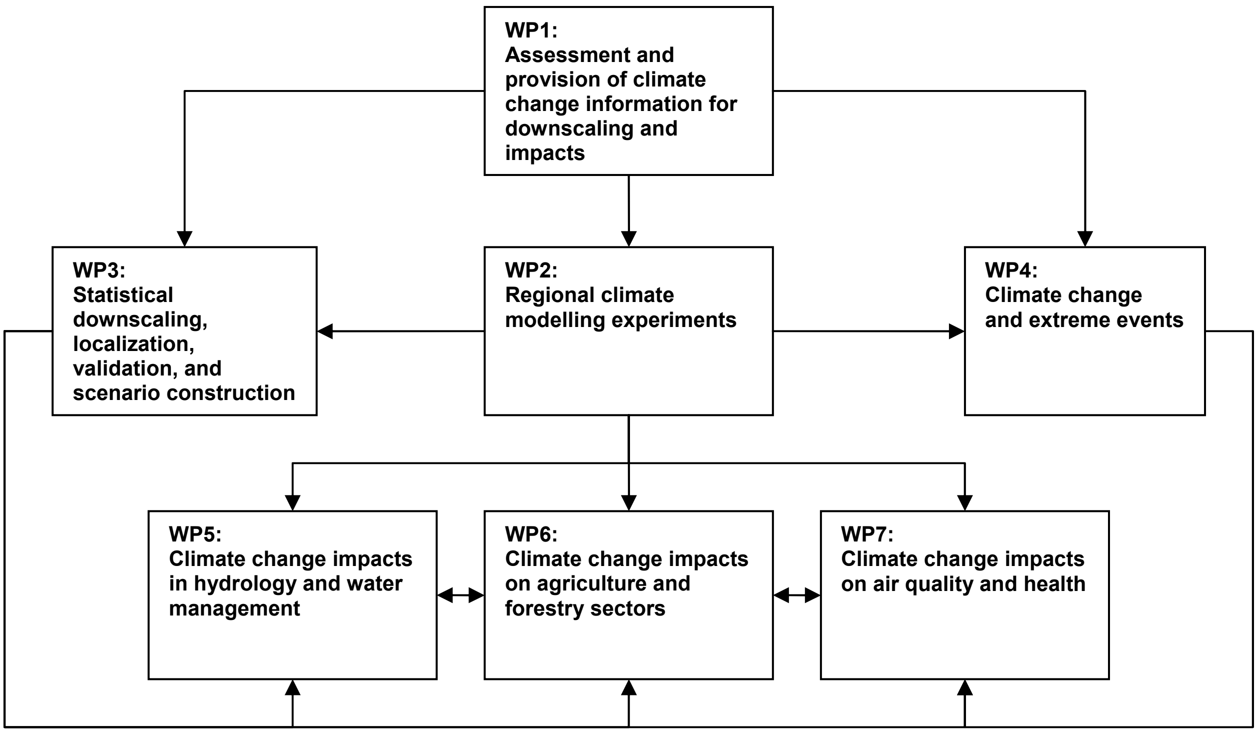

Figure 1. *Interactions between the workpackages*

1.1.3 Technical approach

The project CECILIA brings for the first time very high resolution localization of climate change scenarios into the targeted areas of CEE. Improving upon the project ENSEMBLES where Europe-wide scale is adopted at high resolution, here we address even higher resolutions on a significantly smaller domain. This higher resolution enables not only more detailed description of the topography and land use, but it allows to introduce new processes, as interactive interaction of climate change and air quality, subgrid effects etc. However, it requires the adaptation of parameterizations available at coarser resolution. One of the main objectives of this proposal is to adapt a few of the models used for ENSEMBLES (ALADIN-Climate and RegCM) for very high resolution (grid spacing of 10 km) simulations over selected sub-domains. The assessment of the role of significant but previously not resolved topographical features and land-use patterns will be provided in these experiments as well as the evaluation of the sensitivity of the simulations to the choice of the model domain. Development of new features in the parameterization of high resolution physics in the models is expected (e.g. cloud microphysics, chemistry of urban areas etc.). This provides a connection with the EC FP6 Project QUANTIFY, which aims at quantifying the impact of transportation on climate change. In the region of CEE the need for high resolution studies is particularly important due to the appearance of complex topography features as Alps, Carpathians basin and smaller mountain chains and highlands in most of the countries that significantly affect the local climate conditions. A resolution sufficient to capture the effects of these topographical and associated land-use features is necessary as illustrated in Fig. 2, where comparison of topography representation in different resolutions is presented in the detailed view on the Czech Republic.

The most reliable source of information on the evolution of the atmospheric environment in the next decades comes from RCMs. It was demonstrated in PRUDENCE that the major source of uncertainty for RCM was the driving GCM. It is thus essential to use at least two GCMs (ARPEGE and ECHAM5). Since ARPEGE and ALADIN have been written and developed to work with each other and RegCM has been used already with ECHAM5 as well, it is natural to use these two pairs. As the forcing GCMs introduce their own systematic errors in the regional climate, a first step consists of forcing the high resolution RCM with data as close as possible to observation. The ERA40 dataset provides a good forcing at 150 km resolution, the other 3 RCM simulations are snapshots driven by GCM conditions: 1961-1990, 2021-2050, and 2071-2100.

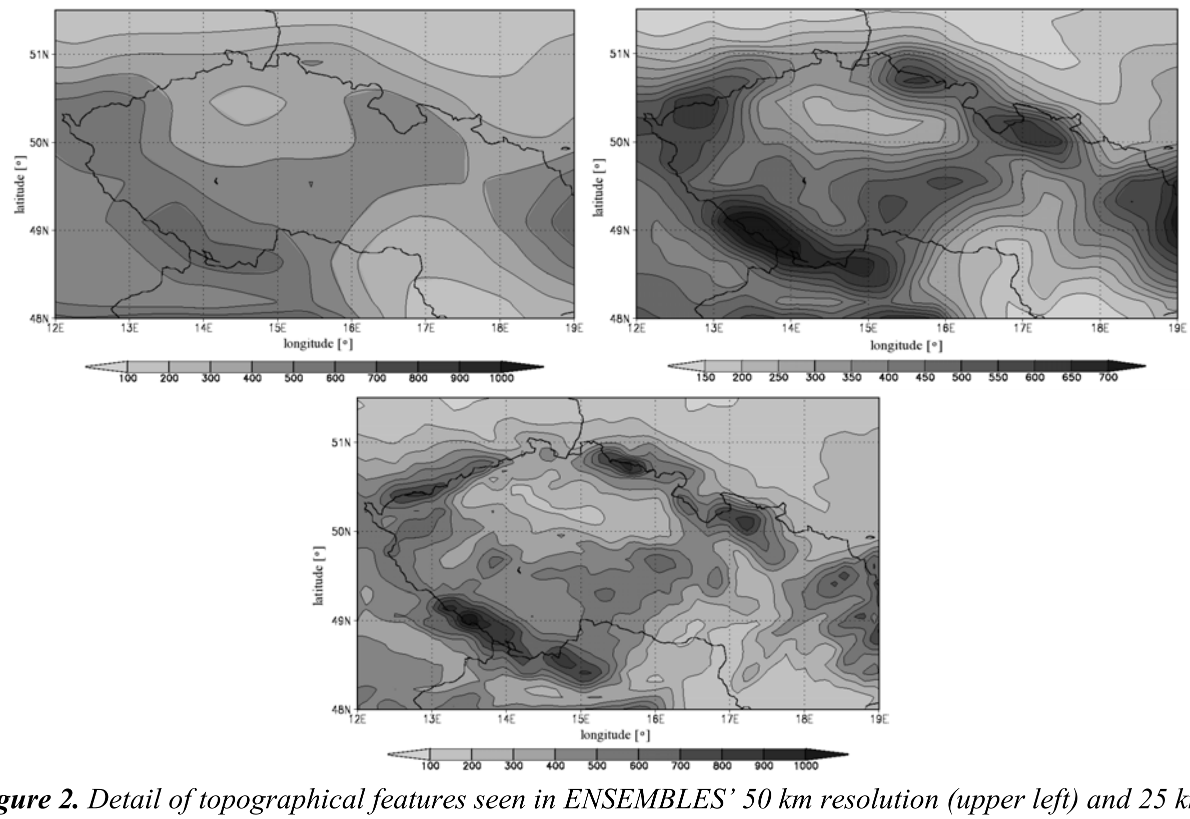

Figure 2. *Detail of topographical features seen in ENSEMBLES' 50 km resolution (upper left) and 25 km (upper right) and 10 km for CECILIA proposal (bottom panel).*

Statistical downscaling (SDS) is an alternative approach to get high resolution insight to climate change issue. SDS consists of seeking statistical relationships between the variables simulated well by GCMs and the surface climate variables of interest. These relationships are usually trained on observed data and then applied to the control and perturbed GCM outputs, the former serving for verification and the latter for climate change scenario construction. As for the methods, the majority of SDS studies employ linear methods, most notably multiple linear regression and canonical correlation analysis. Nonlinear methods have recently begun to emerge as well. The added value in the project consists mainly in a complex intercomparison of performance between the dynamical and statistical models. The ability to simulate extreme values is also of great importance. RCMs even at high resolutions of less than 20 km do not provide site-specific information required in many impact models, which becomes relevant especially in regions with complex topographical features as typical in focal areas of the project. Methods for localization of model outputs have recently been proposed based on regression against geographical variables, with the residuals being interpolated using geostatistical methods. An alternative procedure is a MOS-like approach using model variables as predictors.

Previous results show the possibility of the changes of statistical distribution of climate parameters in our targeted domains. Despite the relative agreement of climate-change scenarios concerning the changes in extremes over this region, a significant uncertainty remains with regard to their exact magnitude and the attribution of the causes for these changes. Some studies have highlighted the role of large-scale circulation changes, but land-atmosphere interactions are clearly of key relevance as well. Moreover, certain aspects central to this issue are often not well represented in GCMs (land surface heterogeneity, complex topography, convection), or even in RCMs. Very high-resolution simulations could help investigating some of these open questions and yield more accurate estimates of future changes in extreme weather events over the targeted regions. Other issues that need investigation are the effects of domain size on the simulated processes, choice of parameterizations and boundary conditions.

The impacts of climate change on hydrology will be estimated using scenarios for changes of climatic inputs to a hydrological model. Improved models have been developed to simulate water quantity and quality involving representation of the physical processes. The climate change has potential effects on the components of the water balance (precipitation, evaporation, soil moisture, groundwater recharge and river flows) and their variability over time. In a river basin the hydrological variability over time is influenced by variations in precipitation over all the time scales. Flood frequency will be studied in high resolution scenarios of climate change which bring more precise information based on better definition of the catchments. The frequency of low flows is affected primarily by changes in the seasonal distribution of precipitation, year-to-year variability, and the occurrence of prolonged droughts. Climate change has the potential to affect all of these factors in a combined way that is not yet clearly understood. The local effects of climate change on soil moisture will vary not only with the degree of climate change but also with soil characteristics where high resolution of the simulations might be of the great importance. Groundwater is the major source of water, particularly in rural areas in arid and semi-arid regions, but there has been very little research on the potential effects of climate change. The great number of hydrological studies has concentrated on potential changes on streamflow. To estimate the impact of climate change on the hydrological resources, mathematical rainfall-runoff models are used for the reference basins. These basins are selected based on the assessment of the vulnerability of water resources and corresponding adaptation measures. Models can be applied both in the case of present regime and regimes of climate change scenarios taken from downscaled results. When taking the results of statistical downscaling the use of weather generators is required to obtain inputs for most hydrological models, in the case of very high resolution RCMs both spatial and time resolution could be satisfactory for direct input to the basin models. The assessment of water quality changes and impacts on availability and management of surface water resources are important as well. This implies the analysis of hydrological balance changes, nutrient (N, P) concentrations and eutrophication in a river network with reservoirs used for drinking water supply and recreation.

The increased content of CO_2 in the air stimulates photosynthesis. At the same time, higher ambient CO_2 allows to reduce the transpiration intensity through decreased stomatal conductance, especially under higher temperatures. This should lead to improved water use efficiency by plants and thereby to a lower probability of water stress occurrence. The impact of the changed weather regime brought about by the CO_2 increase is referred to as "indirect effect" or "weather effect". The most important weather variables that directly determine the crop yield are solar radiation, precipitation and temperature. If no management response (e.g., other cultivars, change in the planting date or soil water conserving practices) is applied, cereals in general yields typically decrease with increasing temperature due to a shortening of phenological phases. On the other hand, the crop response to high temperatures clearly depends on the character of the temperature increase as well as the developmental stage of the crop. There are major gaps between the actual and attainable yields of crops, attributable largely to pests, diseases and weeds. Therefore predicting the potential distribution of all pests, both indigenous and introduced, plays a key role in determining the effects of global change effects on agricultural, horticultural and forest ecosystems. The distribution and intensity of current key pests and diseases may be affected, leading to changed effects on yield and on control measures such as pesticides and integrated pest management. However, as it was stated in the IPCC (2001) only modest progress has been made in understanding pests response to climate change since the last comprehensive overview.

Climate change and other pressures will alter future carbon (biomass) storage in forests, but the regional extent and direction of change is still unknown. Research reported since the early nineties confirms the view that the largest and earliest impacts induced by climate change are likely to occur in mountainous and boreal forests, where changes in weather-related disturbance regimes and nutrient cycling are primary controls on productivity. Forest growth has increased during the past several decades in European forests; climate warming, increasing CO_2, increased nitrogen deposition, and changes in management practices are factors that are assumed to be behind the increase. The impacts of temperature and CO_2 have been shown in experiments and are extrapolated by model calculations.

The concentration of air pollutants depends on both anthropogenic and climate factors. A main issue is the quantity of emissions of primary pollutants as well as of precursors of secondary pollutants. Long range transport to the target regions will be taken into account by simulation for the whole Europe, driven by RCM with a grid resolution of 50x50 km. These simulations will be used to constrain nested higher resolution runs (10x10 km) for a smaller domain focusing in CEE both for present and future climate. The key species will be ozone, sulphur and nitrogen as well as PM, which have a central role in tropospheric chemistry as well as the strong health impacts. Emphasis will be given to future key species exceedances of the EU limits for the protection of human health, vegetation and ecosystems as well as WHO guidelines. Another risk factor for the human health, which finally goes hand in hand with the issue of air quality through the chemistry of pollutants, are heat waves, and in certain extent even cold waves. The summer of 2003 encompassed one of the most severe heat waves on record in central and western Europe causing both human losses and damage to natural ecosystems. First guess of possible impacts of climate change on mortality and attempt to split the direct effect of heat and cold waves from the effects of air quality will be given on the basis of this study. Climate change may affect exposures to air pollutants by a) affecting weather and thereby local and regional pollution concentrations; b) affecting anthropogenic emissions including adaptive response of increased fuel combustion for fossil fuel-fired power generation; c) affecting natural sources of air pollutant emissions; and d) changing the distribution and types of airborne allergens. In addition, the chemical composition of the atmosphere may in turn have a feedback effect on the local climate. Weather is also associated with energy demands (e.g., for space heating and cooling) that could alter patterns of fossil fuel combustion. In particular, individual responses to extremely hot weather can result in large increases in air conditioner use. In addition, high temperatures cause increased VOC evaporative emissions when people run motor vehicles. The health effects of air pollution are broad and diverse, including dramatic episodes of increased mortality at high concentrations. In humans, the pulmonary deposition and absorption of inhaled chemicals can have direct consequences for health. Nevertheless, public health can also be indirectly affected by deposition of air pollutants in environmental media and uptake by plants and animals, resulting in chemicals entering the food chain or being present in drinking-water and thereby constituting additional sources of human exposure. Furthermore, the direct effects of air pollutants on plants, animals and soil can influence the structure and function of ecosystems, including their self-regulation ability, thereby affecting the quality of life. The most sensitive groups include children, older adults and persons with chronic heart or lung disease.

1.1.4 Expected achievements/impact

Although the broad response of global climate to increased greenhouse gas concentrations is well established, many unknowns remain in the regional details of projections of future climate change. Thus, the central internal objectives of CECILIA are to improve regional climate scenarios and their localization for climate impacts models, and comparing these results against the results of previous and ongoing projects to assess the added value of dynamical downscaling at very fine scales. The general aim of CECILIA is to improve Europe's ability to assess the consequences of global climate change at the local scale, and on this basis to assist to formulate more precise response strategies and more scientifically based negotiating positions. Such an effort will assist in the successful implementation of the FCCC (Framework Convention on Climate Change) and the Kyoto Protocol, for the negotiations in the post Kyoto process and in regulations to mitigate the possible consequences of climate change as concluded by IPCC. Very high resolution and better regional predictions are required to guide long term planning in sectors such as agriculture and energy.

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This project brings very high resolution localization of climate change scenarios into the targeted areas of CEE, with the added value of climate scenarios produced locally. This will provide necessary policy relevant information concerning the local adaptation and/or mitigation measures. Moreover, it will provide know-how and tools which can be further used for the analysis of the climate change development and climate change impacts on different sectors of the society in the target region. With the emphasis on former Eastern Block countries the CECILIA project will provide new access and contacts for researchers from this area to the European research activities and thus help to bridge existing gaps. An important point of innovation consists in the fact that very high resolution climate information will allow application in integrated climate change impact studies, which will in turn provide for the first time necessary policy relevant information for decision makers and local authorities in the region.

1.2 Objectives, work performed, contractors involved and the main achievements in the period

The main emphasis of the first year of the CECILIA project was on preparatory tasks in all the aspects of the project. For climate change simulations in high resolution main task was to complete the simulations providing the boundary conditions for RCM runs in full extent of the time scope of the project, i.e. till the end of the century. Development and testing the models in very high resolution and localization for the targeted areas were the tasks for the first period of the project. For validation of the model runs in perfect boundary conditions (ERA 40) and for statistical downscaling techniques data collection should have been started. On the climate science part of the project the collection of sets of various indices was expected as well in cooperation with impact community to address its needs. Beside the work preparing the background for the climate change analysis in local and regional scales, preparatory activities were planned to start in the individual impact sectors with developments and tests of proper impact models and tools application in the targeted territories and for problems defined in the DoW. As the very high resolution simulations performed for the project will be available in later stage of the project, overview on previous results available was scheduled in the first year of the project to provide the impact community first insight and preliminary information.

1.2.1 WP1

In WP1 there were two main tasks of the first year, which were covered mainly by ICTP and CNRM, with small support of CUNI, DMI and ETH. Basically, this has been the overview of the previous results, based mainly on PRUDENCE project RCM's results and IPCC 4AR global models, which provides for the project CECILIA the first more detailed information on the climate change in the targeted regions. These results are in much extent described in the D1.1 and for individual countries provided by means of D1.2, as required by M1.1. Here we present as a major achievement of the first project year just annual average temperature and precipitation of PRUDENCE RCMs signal for IPCC SRES scenarios A2 and B2 for the targeted areas. Beside of this overview studies, the work toward the other important task of WP1, i.e. the completion of the climate change scenario simulations till the end of the century for A1B global stretched simulation with ARPEGE and A1B 25 km ENSEMBLES run of ICTP RegCM, has been started to provide boundary files for high resolution simulation, which should be available due month 18.

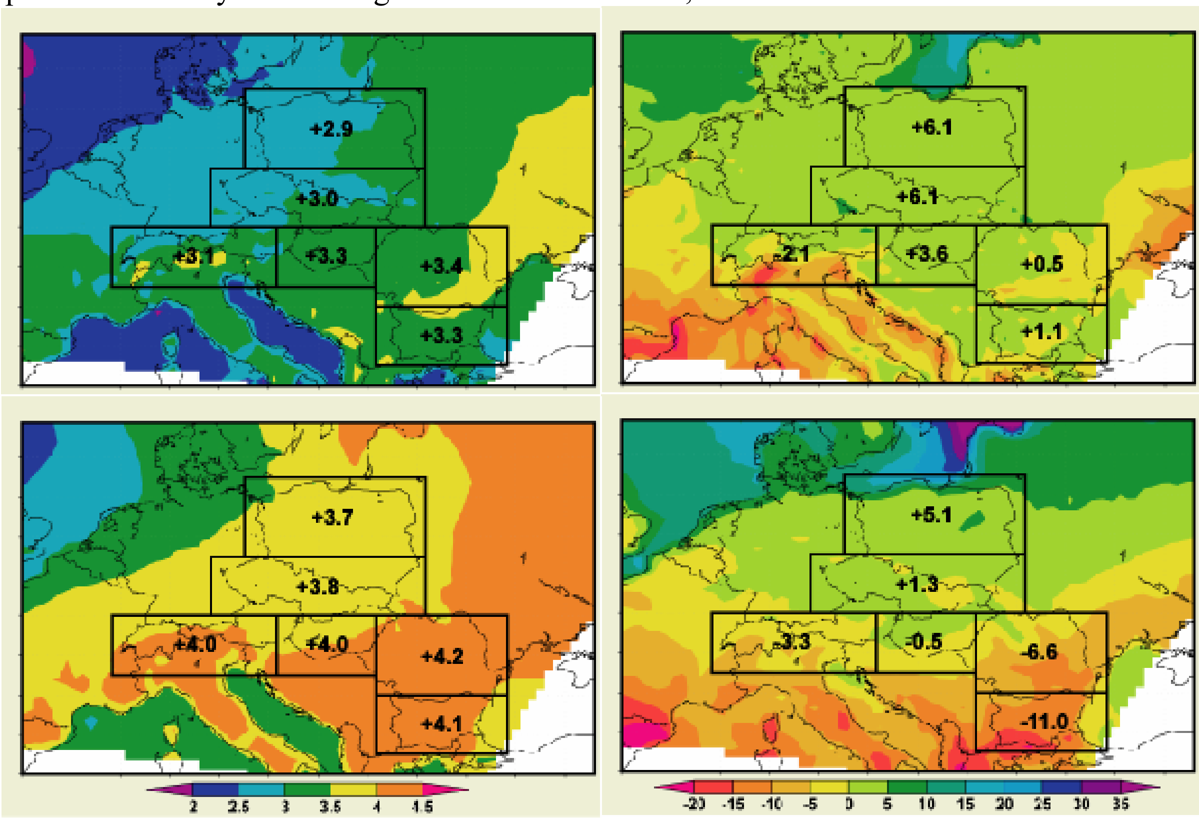


Figure 3. *Change of temperature (°C – left column) and precipitation (% - right column) in 2071-2100 relative to 1961-1990 in the CECILIA target areas for emission scenarios A2 (bottom panels) and B2 (upper panels).*

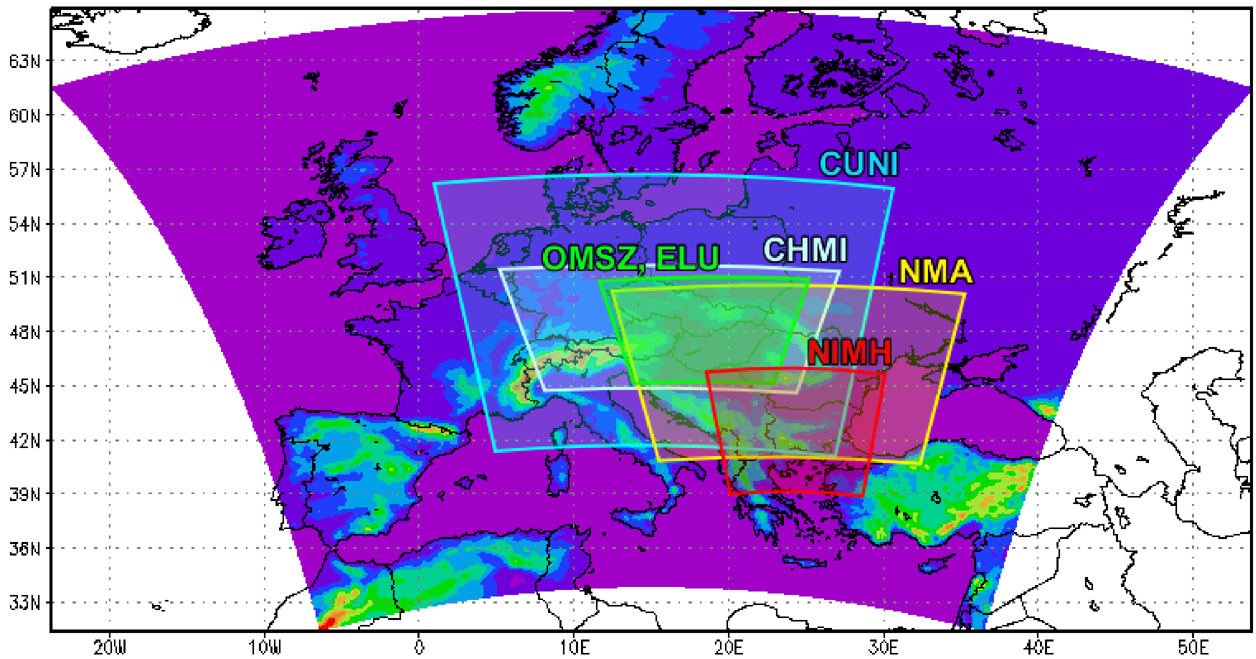


Figure 4. *Integration domains of individual partners in targeted regions.*

1.2.2 WP2

The main objective of WP2 is to produce simulations on targeted domains for a past period (1961-1990), a reference period (control) and two scenario time slices (2021-2050 and 2071-2100) based on AR4-A1B GCM projections. During the first year of the project, the main activity was to define the new high resolution models from the existing material (RegCM and ALADIN). To achieve the milestone M2.1 the individual partners integration domains were settled as shown in Fig. 4. CNRM has prepared the lateral boundary conditions from ARPEGE GCM for the three ALADIN models already. ARPEGE is a global model with 50 km resolution over Europe. CNRM has also investigated the potential problem of the jump in resolution between forcing data (120 km to 10 km). ICTP has provided ERA40 driven RegCM runs at 50 km and 25 km resolution to the three partners using 10 km resolution RegCM for high resolution model testing. DMI has started to prepare the database which will host the simulations results. CUNI has started the simulation based on reanalysis, both directly from ERA40 and, due to the big step between ERA40 resolution, from RegCM reanalysis run of ICTP for ENSEMBLES project in 25 km. CHMI has performed short time (1 month) high resolution simulations with ALADIN to assess the overall cost of integrations in frame of the project and to evaluate its feasibility. NMA has tested two domains with RegCM (one covering only Romania, the other a larger area) and two convection schemes. Improvements are obtained with the larger domain, but double nesting does not bring any relevant improvement. ELU and OMSZ agreed on the central domain of simulations for the Carpathian basin. ELU tested vertical resolution, parameterization scheme, and time resolution with RegCM. OMSZ realised climate simulations with 10km and 25km versions of ALADIN for a 10 years period (1960-1969) NIMH performed a preliminary 10-year simulation (1990-1999) with ALADIN over Bulgaria. Simulated 2m temperature was compared with station observations, and showed that reasonable downscaling up to 10 time finer resolution than ERA40 can be obtained by regional climatic models.

The second objective of WP2 is to explore the possible improvements of high resolution regional climate modelling by testing new parameterization schemes more adapted to this resolution. AUTH has studied Emanuel vs Grell convective parameterizations in European Regional Climate Model simulations with RegCM3. Further test are planned based on the analysis of perfect boundary conditions experiment (driven by ERA 40 reanalyses) after the delivery of scenarios runs for impact studies. At present stage none of the partners has achieved the 30-year ERA40-driven simulation to be delivered at month 18, but all partners have a model ready to run and computer resources to perform the integration in due time.

1.2.3 WP3

The main tasks of WP3 in the first year of the project were construction of statistical downscaling models for the target areas/stations and variables as well as the development of techniques for localization of RCM outputs into the stations. This work has been performed mainly by IAP, BOKU, NMA, with some contribution of CUNI and NIMH and it is covering mainly the theoretical contribution and development or adaptation of techniques available in individual partners. Due to certain data provision restrictions the building of observational database for the project (part of M3.1, D3.1) is delayed and necessary measures were adopted to cope with the problem.

Preparation of the observational data for common territory (D3.1) remains one of the important tasks of the project giving the opportunity of real cooperation of the teams from individual partners involved. An agreement was made on the creation of a common dataset to be used mainly in validation of models and statistical downscaling, covering part of central Europe over the borders of the Czech Republic, Austria, Slovakia, and Hungary. The list of variables needed in the impact studies, including their temporal resolution and time period, was set up. The data were retrieved from the respective national meteorological services and sent to CHMI for further processing, i.e., creation of technical data series, which can be made available for the CECILIA partners. Participating partners for this region will be CHMI, IAP, BOKU, FRI, OMSZ. Other datasets were compiled in Romania and Bulgaria, with the aim of applications in statistical downscaling model building and agricultural and hydrological impacts, mainly by the respective partners, i.e. NMA and NIMH.

Another important issue for the project is the model output localization (D3.2, due month 18, based on statistical downscaling techniques, developed and adapted for the project as required by M3.2). Mainly preliminary work was carried out on this topic that includes the agreement on the basic principles, selection of methods, as well as the selection of pilot areas where the methods will be tested. The methods to be used by BOKU and CUNI already underwent preliminary tests on limited areas with the contribution of ELU, CHMI and NIMH.

In addition to the previous tasks under WP3 the validation of RCMs and statistical downscaling (SDS) results as well as their comparison is supposed and being prepared (D3.3). The list of criteria for validating RCMs and SDS models was prepared with the contribution from impact research within WPs 5 and 6 incorporated to keep the relevancy of the criteria for these applications. The matrix displaying a distribution of criteria among partners involved (IAP, CHMI, CUNI, BOKU, ELU, OMSZ, NMA, NIMH) was set up. Within this deliverable, the SDS models were also implemented and prepared for their application in further work. The models include multiple linear regression, canonical correlation analysis, various kinds of non-linear methods, including neural networks, classification-based methods, and stochastic downscaling approach and participating partners for this task are IAP, CUNI, NMA and ELU.

1.2.4 WP4

In the first year of the project, WP4 planned to start with focus on the analysis of extreme events in Central and Eastern Europe from observations, with the possible identification of existing trends in the recent period. Beside regional datasets (e.g. European Climate Assessment & Dataset, ECA&D), in WP4 the analysis of local datasets available to the individual WP4 partners (CHMI, ELU, NMA) in cooperation to WP3 was supposed to be performed. The suitability of other datasets available from local sources has been assessed in collaboration with all WP4 partners, together with the selection of the sets of extreme indices (WMO, STARDEX) relevant for the analysis, which was main task of the WP4 in framework of this period of the project (D4.1). Further task already started as well for D4.2 was the application of this indices analysis on the previous available model data from simulations for PRUDENCE and later on for ENSEMBLES with the assessment of the added value of 10km resolution (one set in 12km resolution available). Particular consideration will be given to intensity distributions, extremes indices, as well as relevant feedback processes.

As required by M4.1 all the WP4 partners, i.e. ETH, DMI, CUNI, NMA, CHMI, ELU, IAP, OMSZ, ICTP, AUTH and NIMH compiled a list of 131 climate and extreme weather indices defined for the D4.1, which will be used for the analysis of the present-day and projected future climate. The indices will be processed both for model and observational data. These observational datasets have been defined as well and the local WP4 partners will compute the extreme indices for these data. These indices are not subject of the restriction mentioned in WP3. For this purpose, the software ProClimDB has been finalized at CHMI and accepted for the use to cover needs of WP4 (http://www.climahom.eu/ProcData.html). This software will be used by the WP4 partners to achieve the consistent calculation of the climate indices.

1.2.5 WP5

The activity of WP5 partners (CHMI, IAP, FRI, NIHWM and NMA) in the reporting period aimed mainly to the calibration of the models which will be use by each partners for assessment of climate change impacts on hydrology and water management in the reference river basins, as required by M5.1. Another task was dealing with observational data analysis for Black Sea costal area as well as with the calibration of the model with respect to water quality. The work was covered by three deliverables. For studying the impact of a potentially altered climate on flow from analysed river basins the rainfall- runoff processes in monthly time step are analysed for D5.1. The following conceptual hydrological balance models have used: WatBal model in Buzău and Ialomița area (17 cross-sections), BILAN model in Dyje river basin (2 cross-sections) and KVHK model in Hron river basin (9 cross-sections). All these models are of two main modelling components. The first is the water balance component that uses continuous functions to describe water movement into and out of a conceptualized basin and the second is the component, which allow to compute the potential evapotranspiration. Time series inputs need for the calibration of the parameters of models include the monthly values of precipitation, temperature and ambient air relative humidity, sunshine hours, wind speed and mean monthly discharges in the analysed sub-basins. For all the analyzed sub-basins the runoff for the period 1971-2000 was simulated, which was compared with the appropriate observations for an evaluation of the results.

The ability to simulate flood events in the Dyje catchment with the use of hydrological model HYDROG was tested on historical and recent flood events for D5.2. For simulation of historical floods the time and spatial resolution of input precipitation data is not sufficient, nevertheless, the hydrological simulations proved that the HYDROG model is able to simulate the floods. However, the error of the peak discharge was considerably large sometimes. Although the operative hydrological modelling in the Czech Republic has been available since 1996, the strong demands on higher density of a raingauge networks were given after year 2000. The great improvement has been brought since year 2002, when the computation of the quantitative precipitation estimates (QPE) based on radar measurement combined with information from raingauges started. In this way we can get the precipitation amount of a sufficient accuracy. Thus, the hydrological simulations of the recent floods (August 2002, March 2005, March-April 2006, June 2006) using the input rainfall from the radar QPEs combined with raingauge measurement were much more accurate than the simulations of historical floods.

The evaluation of climate change impacts on the quality of surface water resources in the Vltava River basin, Czech Republic, started according to the work plan with two tasks: (i) analysis of natural conditions, land use, water quality, and water management and (ii) setup, calibration and validation of hydrological and water quality models. The analysis of natural and man-induced variability in the climate conditions, runoff and water quality in the river network was done for the period from 1961 to 2004. A highly significant increasing trend of temperature was detected at most climate monitoring stations in the basin with the annual increase ranging between 0.02 and 0.03°C. On the other hand, no trend was detected for other examined meteorological and hydrological quantities (precipitation, humidity, radiation, velocity and direction of wind, stream flow). Water quality in the river network and reservoirs experienced significant changes during the studied period that were connected mainly to the development of population, municipal and industrial wastewater discharges into surface waters and the intensity of agriculture in the basin.

The modelling system consisted of two models – the precipitation-runoff and water quality model in the river network (HSPF) and the reservoir hydrodynamics and water quality model (CE-QUAL-W2). HSPF was calibrated for hydrological simulations in the whole basin with the daily and monthly time step with a sufficient precision, in correspondence with the quality of input data. Simulations of water quality constituents (suspended solids, phosphorus fractions) in the runoff were highly dependent on the correctness of flow modelling. HSPF/CE-QUAL-W2 modelling system was calibrated and validated for simulations of both hydrology and water quality at the sub-basin of the deep, dimictic Rimov Reservoir, where sufficient data existed for this purpose. Temperature stratification and water column mixing in the reservoir were simulated quite realistically. Phosphorus concentration (which is the key factor for eutrophication and water quality in all reservoirs of the Vltava River basin) was reproduced with a partial success – the timing of seasonal pattern and summer concentrations were modelled correctly but the size of concentration amplitude during the winter period was biased. In spite of this partial imprecision of the model the system is suitable for the planned impact studies.

In the reported period a climatological analysis was also accomplished in order to identify changing points in the local climate variability and to make attribution either to natural phenomena or to local anthropogenic influences (such as the influences of Black Sea – Danube channel on local climate and air-sea interactions from 1984 onward).

1.2.6 WP6

The WP6 planned to prepare the background for the analysis of the impacts on agriculture and forestry sectors. Major tasks were selection of the regions and crops to be analyzed and collection and preliminary analysis of the observational data. Climate change is one of the driven forces that can significantly influence both sectors due to direct effects of climate change on the crop yield, tree growth, water balance, weather extremes, drought occurrence, land use change, pests and diseases (IPCC 2001), most factors can be included into the appropriate impact models, which has to be adapted for selected species and calibrated for appropriate region of interest. Another task supposed the preliminary assessment of the change in crop yield and its quality under the different climate scenarios (first stream data from WP1) for the selected regions under current production and land-use systems as well as of the impact on forest tree growth under the different climate scenarios for the selected regions under current management systems.

For the D6.1 the report on results of the crop yield and forest tree growth changes influenced by climate change, regional conditions and management systems was submitted delayed of 6 month against expected month 6. This happened due to not clear situation of the other duties and finally leaving the position of WP leader by dr. Mindas and finally his replacement with dr. Hlasny from the same institute (FRI). There are the target regions used for climate change impacts analysis described in this report, as well as proposed models and algorithms; and available data sets. Climate change impacts on selected crops, forest tree species and carbon cycle were evaluated as well. The contractors involved are IAP, BOKU, FRI, NMA, ELU, NIMH.

Another deliverable D6.2 delivered in time is analyzing the results of the drought damage potential and crop water use efficiency as influenced by climate change effects and regional conditions. In order to asses vulnerability to drought phenomenon spatially and temporally, historical data of precipitation, soil moisture, and crop water requirements were analyzed for the target areas. Various simulations for climate change scenarios were also performed for estimation of drought impact on agricultural production. Soil characteristics for most of the regions were taken into account for differentiated estimations according to local conditions.

1.2.7 WP7

The main goal of WP7 is to investigate the impact of the anticipated future climate change on air quality and health. WUT, CUNI, CHMI, AUTH, BOKU and NIMH are involved in the tasks using off-line coupled modelling system of RCM and CTM for evaluation of the impact of climate change on air quality. To exploit the sensitivity of air quality to potential climate change, four modelling groups (AUTH, BOKU, CUNI and WUT) will use for their simulations RegCM coupled to CAMx (Comprehensive Air quality Model with extensions), from ENVIRON International Corporation (Novato, California), while two groups will apply the similar procedure as the extension of the tasks with ALADIN-CLIMATE, coupled to CAMx (CHMI) and CMAQ Model (Community Multi-scale Air Quality) from US EPA (NIMH).

For the first reporting period the main objective of WP7 participants was coupling of the AQM's to the RCM's by development of the pre-processors to convert RCM-output to AQM-input (Deliverable D7.1). Thus, the main WP7 achievement of the first year is the development of the interface between RegCM and CAMx. The pre-processor has been written at CUNI and delivered to AUTH, BOKU and WUT, where it was installed and tested. Coupling between ALADIN-Climate and CAMx is in the final stage of preparation (CHMI). Prognostic version of ALADIN has been coupled with CMAQ already, modification to ALADIN-Climate is under the progress. One year test runs for the year 2000 were performed at AUTH, BOKU by coupled RegCM-CAMx modeling system on the ENSEMBLES grid with a 50 km resolution while at CUNI the tests were performed in targeted 10 km resolution. The anthropogenic emissions (calculated with the emission model of BOKU-Met based on data from the UNECE/EMEP data base) were combined with biogenic VOC emissions. Results of the test runs were preliminary compared to observations leading to the conclusions connected with future boundary conditions use. As a result of this common work the AQ photochemical models have been prepared for their further tasks, in particular the preparation of European background concentration runs with 50 km resolution, due to Deliverable D7.2 by month 18 of the project.

In accordance with the Milestone M7.1: "Selection of the air-pollution episodes to be simulated from the offline and online chemistry AQMs, the participants chose episodes, i.e. the periods of time in past when high concentrations of primary (mainly SO2 and PM10) or secondary (O3) pollutants occurred. For Czech Republic and Poland episodes from 1997, 1998, 2000 and 2001 were chosen. Another ozone episodes, which were chosen by AUTH, occurred in summer 2003. Although it is outside the standard decade of past climate, the climatic conditions were extremely unusual and hence analysis of such a hot spot of present climate give an excellent opportunity to investigate how regional climate/air quality simulations migh behave.

1.3 Problems during the period, corrective actions

As mentioned in the sections above, there were basically two more important issues which might have implied the problems on the project development. One of them was the difficulty to get the observation data from some regions due to data policy of some Meteorological Services, which produced delay of D3.1 as well as part of the requirements of M3.1. These problems have made tuning of the tools and mainly their validation which need the use of such data more complicated. Original concept of testing the tool of individual contributing partner in whole targeted regions using the data of all the partners became useless, the concept of methods and tools sharing was not possible as it would be difficult to ensure the correctness and proper use of the tools. Moreover, it would not be easy to transfer all the know-how generally between the partners, not all the techniques (especially for SDS) are available as a very comprehensive and user friendly tools, as it is the case of basic statistical analytical package ProClim used for the analysis in WP5. The problem was finally solved by the selection of the smaller region for validation and tuning, for which the data will be provided and gridded to the technical series, which may be shared. Thus, the negative impact to the project has been minimized, individual partners in their territory will further use their own original data knowing the performance of the techniques in framework of the methods used in the whole project. It should be mentioned that this problem does not imply the failure of progress in the appropriate work as a whole, it is rather partial problem, for which at this moment proper corrective action has been already adopted and proposed measures are already under progress.

Another significant problem was not well reported interruption of the duties at FRI by dr. Mindas who was assigned with another duty outside of FRI. The situation was not clarified for a longer time and the delivery of Deliverable D6.1 was delayed, although work continued following the plans (M6.1). When finally clarified, the substitution was proposed from FRI and after some discussion at SSG meeting in connection to our project meeting at Semmering it was decided to accept the substitution by new FRI leader in a position of WP6 leader, either. The Deliverable D6.1 missing was finally delivered with the delay of 6 months, next D6.2 was delivered about in time. There are no further negative impacts on the project expected from this problem.

Section 2 Workpackage progress of the period

2.1 WP 1

2.1.1 Workpackage objectives

Main objective of the WP1 for the project is production of intermediate resolution (25-50 km grid spacing) meteorological fields for 30-year time slices of the 21st century necessary to conduct very fine scale regional climate simulations planned in WP2 over targeted areas of central and eastern Europe. For this purpose, basically the simulations of ICTP and CNRM for ENSEMBLES project can be used, except those for the second half of 21st century which was not planned in ENSEMBLES and which has to be completed in the project CECILIA. Another objectives consist in collection and assessment of medium to coarse scale (25-150 km) climate change information for the central and eastern European region available from previous projects and numerical simulations (PRUDENCE, ENSEMBLES, IPCC) and the provision of these information to impact modelers in targeted regions involved in the other WPs for first-stream impact analysis studies, which brings the first information on climate change signal into the project as well as the new data before CECILIA high resolution simulations will be available.

2.1.2 Progress towards objectives

The main workload of ICTP and CNRM for WP1 covers the completion of the simulation of their runs for ENSEMBLES project with the additional 50 years till the end of 21st century necessary for driving fields in WP2 of CECILIA project. Beside this basic task for the project both the partners worked towards the completion of all the others WP1 objectives.

In particular, ICTP completed the Deliverable D7, or D1.1, consisting of the collection and assessment of simulations from previous projects. Two sets of data from previous projects were collected and analyzed over the CECILIA region. The first set was based on data from climate simulations produced with coupled Atmosphere-Ocean General Circulation Models (AOGCMs) participating in the CMIP3 intercomparison project completed in support of the Fourth IPCC Assessment Report (AR4). This dataset includes experiments with 21 models from laboratories worldwide. Simulations for climate of 20th century with observed greenhouse gas (GHG) forcing and for 21st century climate under forcing from three IPCC SRES emission scenarios were available. The three scenarios include the A2, which lies close to the upper end of the SRES scenario range, A1B, which lies close to the middle of the range, and B1, which lies close to the lower end of the range. The horizontal resolution of the models varies from about 1.2 degrees to 4.5 degrees. The data are stored at the web site **www-pcmdi.llnl.gov** and are of public access and a list of the CMIP3 models can be found in this web site. The second set used for the analysis and comparison was based on data from Regional Climate Model (RCM) simulations completed as part of the previous European project PRUDENCE. In this case simulations with 10 RCMs were available for two time slices, 1961-1990 for present day conditions and 2071-2100 for future climate conditions under forcing from two IPCC SRES scenarios, the A2 and B2 (which also lies towards the lower end of the IPCC scenario range). The PRUDENCE regional model simulations were driven at the lateral boundaries by corresponding global simulations with three global climate models. The data are available at the web site **http://www.dmi.dk/f+u/klima/prudence/,** which also reports a description of the participating models.

In order to assess these simulations against observed climate, observations were used from the dataset developed at the Climatic Research Unit of the University of East Anglia (referred to as the CRU dataset). This includes monthly temperature and precipitation data onto a global land 0.5 x 0.5 degree grid for the period 1901-2002. For further analysis the definition of regions of suitable and comparable size is essential since all those results come from relatively coarse resolution simulations and individual grid points or very local assessment would not provide reliable information on the model performance. The proper choice was discussed with other partners participating in the project and finally prepared by CUNI. The selection of 6 specific CECILIA sub-regions was adopted, which together approximately cover the area of interest in the CECILIA project. Although some regions approximately encompass individual countries, the selection itself was mostly based on physiographic characteristics. The regions selected are shown in Fig. 5. They are: Flat north (1), Highlands and mountainous central (2), Alpine region (3), Panonian lowland (4), Carpathian basin (5) and Mountainous south-east (6).

The assessment included two types of analysis. In the first the performance of the CMIP3 and PRUDENCE ensembles of models was evaluated against the CRU observations. In the second the climate change signal produced by these two ensembles was intercompared to assess the robustness of the projected changes. The variables assessed include seasonal mean and interannual variability for temperature and precipitation, where the interannual variability is measured by the interannual standard deviation for temperature and the coefficient of variation (standard deviation divided by the mean) for precipitation.

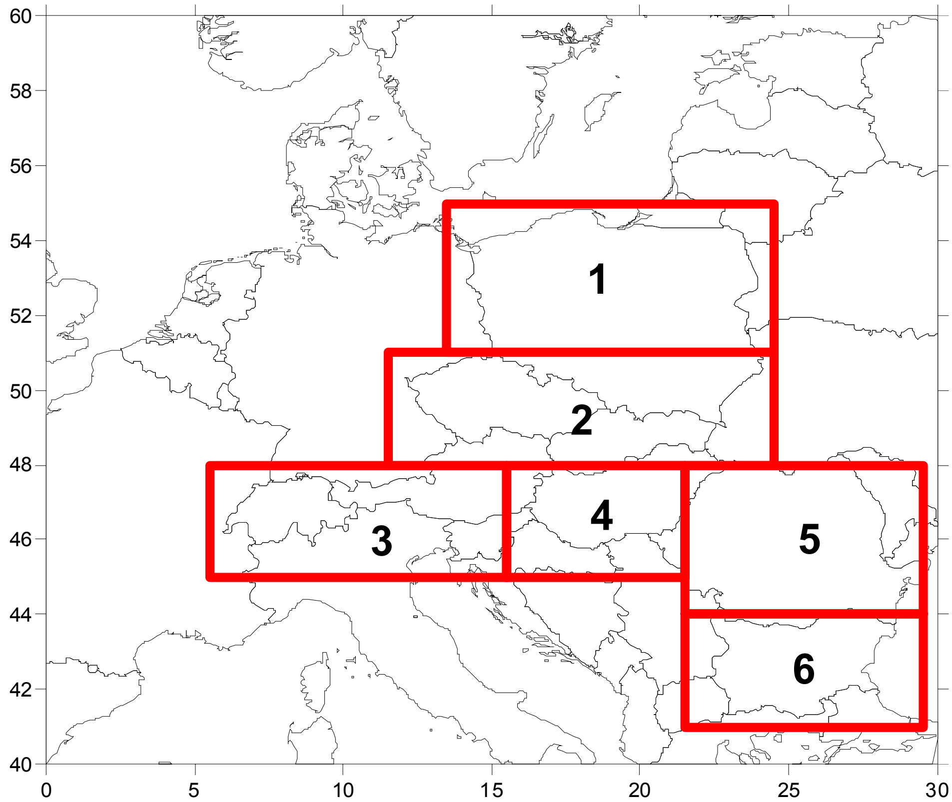


Figure 5: *Regions for previous model results assessment: Flat north (1), Highlands and mountainous central (2), Alpine region (3), Panonian lowland (4), Carpathian basin (5) and Mountainous south-east (6).*

Examples showing the type of assessment performed are given in Figs. 6-11. Figs. 6-9 present maps of the biases (1961-1990) and changes (2071-2100 minus 1961-1990) for the A2, A1B and B2 scenarios in the CMIP3 AOGCMs and PRUDENCE RCM ensembles over the European region for mean temperature and precipitation, respectively, and for two seasons (December-January-February, or DJF; and June-July-August, or JJA). Also reported in the figures are the corresponding values averaged for six selected CECILIA sub-regions. A similar analysis was performed for temperature and precipitation interannual variability.

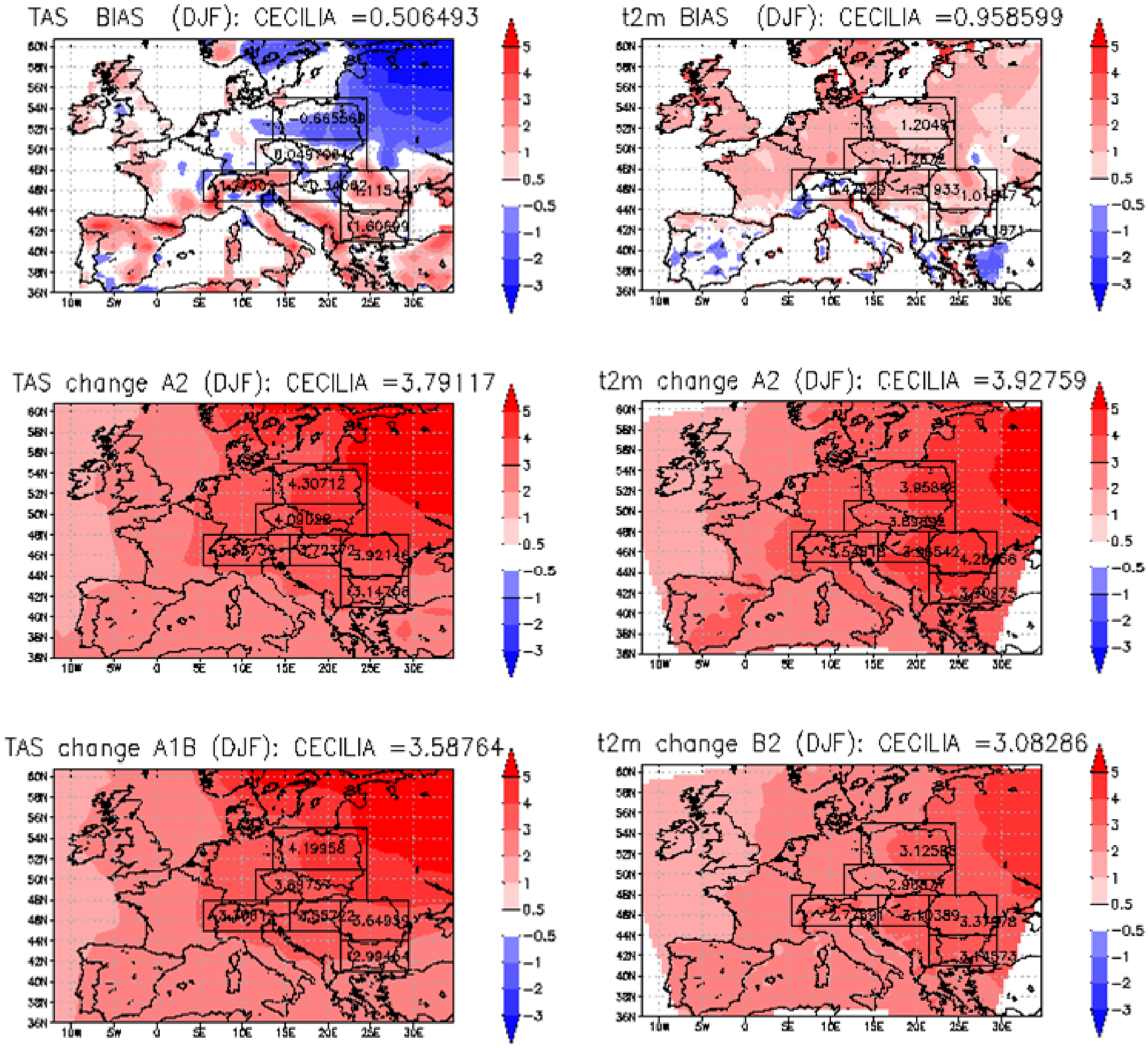


Figure 6: *Mean surface air temperature bias (1961-1990) and change (2071-2100 minus 1961-1990) for the CMIP3 (left column) and PRUDENCE (right column) ensembles and the winter (DJF) season. Numbers in the boxes, which encompass the CECILIA region, indicate averages over the corresponding region.*

Analysis of mean temperature (Figs. 6-7) reveals that the CMIP3 ensemble does not exhibit strong systematic biases, both in DJF and JJA, with areas of positive and negative bias generally less than 2°C. The CMIP3 biases are mostly positive over mountainous regions, as a result of the smooth topography of the models, and over the Mediterranean in DJF. Conversely, the PRUDENCE RCMs exhibit a predominant warm bias over Europe in both seasons, although this is relatively small, especially over the western European regions. Focusing on the CECILIA sub-regions, the temperature biases are less than 2°C except over Romania in JJA for the PRUDENCE models. Biases of the order of 2°C or less are consistent with the performance that can be expected by state-of-the-art models over this region. Analysis of the scenario simulation reveals warming of up to 5. 2°C by the end of the 2100 century, maximum in the southern CECILIA regions in JJA and in the northern regions in DJF. As expected the warming is greatest for the high GHG emission scenario (A2).

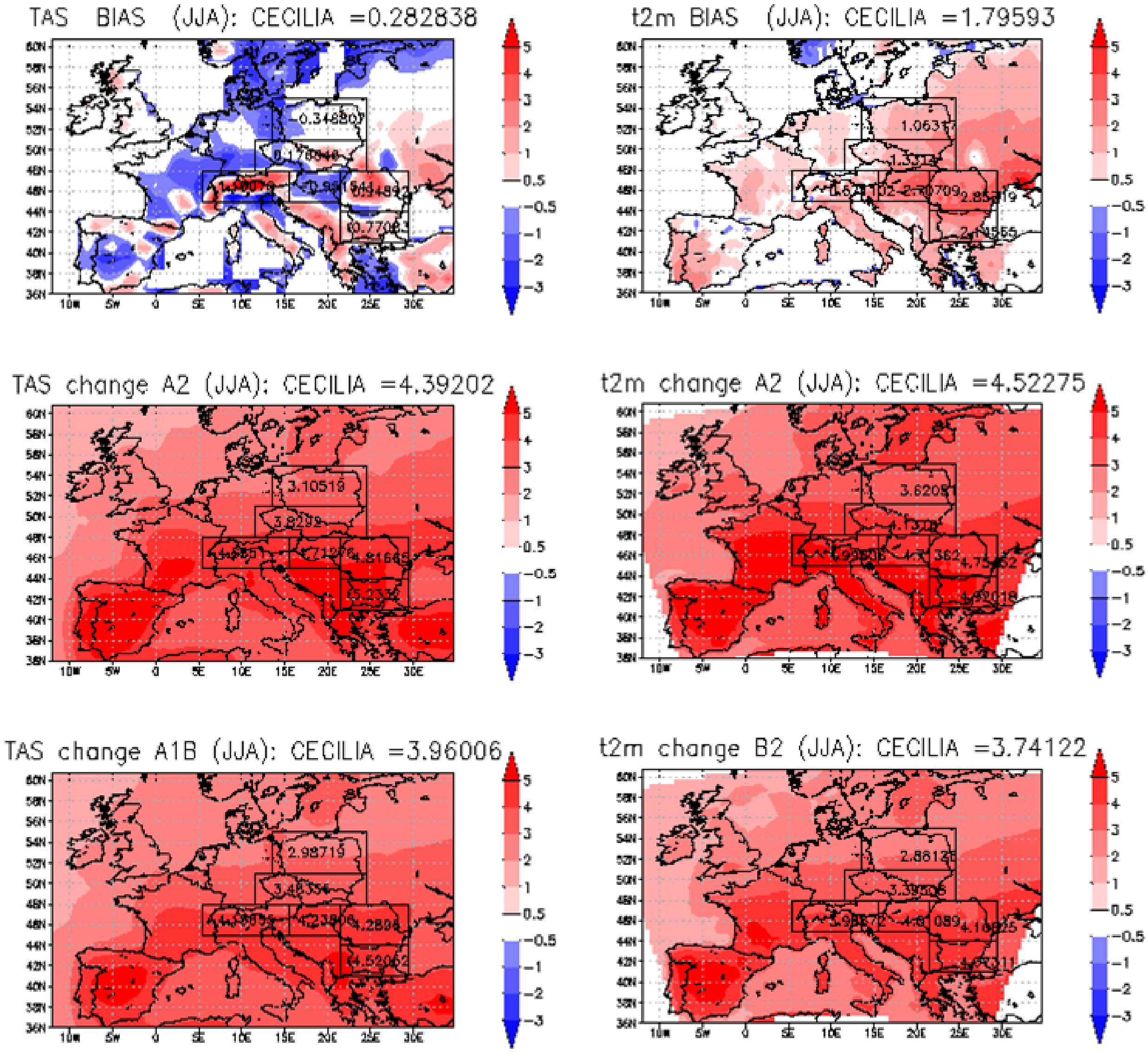


***Figure 7:** As figure 6 but for JJA mean surface air temperature.*

The CMIP3 ensemble tends to underestimate temperature interannual variability over the European and CECILIA regions in DJF, except for the Alpine region, and shows mixed performance in JJA, with a prevalence of an overestimation over the eastern CECILIA regions (not shown). By comparison, the PRUDENCE RCMs show a dominant underestimate of temperature variability over central Europe in DJF and an overestimate in JJA (not shown). The temperature variability change signal is consistent in the CMIP3 and PRUDENCE simulations, with a decrease in the winter and an increase in the summer. This implies that the change signal does not depend on the biases in the present day simulations. The decreased temperature variability in winter can be at least partially attributed to the melting of snow and related decreased efficiency of the snow-albedo feedback mechanism, while the increased in summer variability can be attributed to the drying of the continental interiors and stronger land-atmosphere feedbacks.

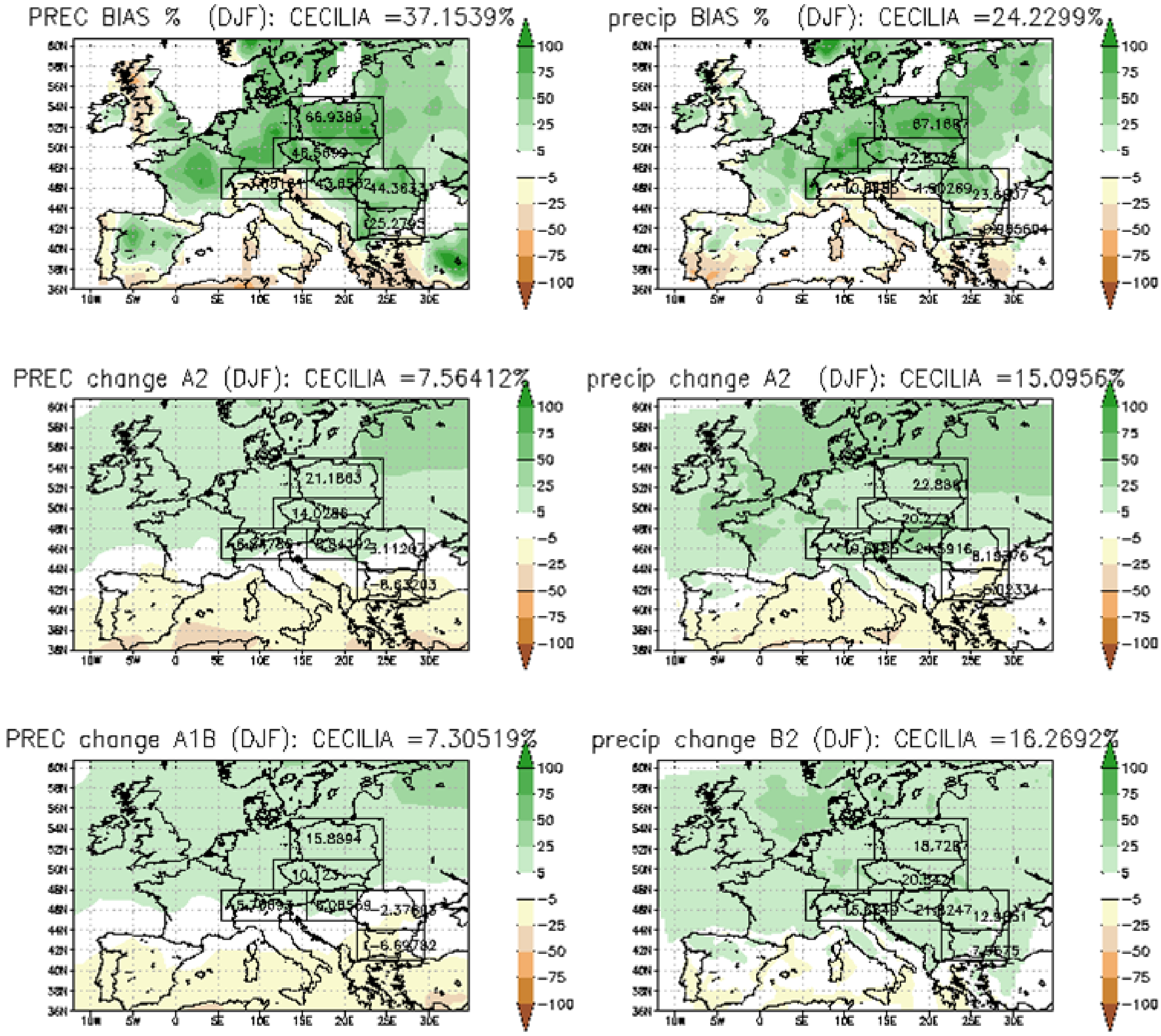


Figure 8: *As figure 6 but for DJF mean precipitation.*

Concerning mean precipitation (Figs. 8-9) the models tend to overestimate precipitation in over the CECILIA regions in DJF and underestimate it in JJA, with consistent biases in the CMIP3 and PRUDENCE ensembles. The JJA biases are mostly less than 30% over the CECILIA regions, while they exceed 60% over the northernmost region. The precipitation change signal is consistent with previous simulations, with a general decrease in summer (maximum in the southernmost CECILIA regions) and a dipolar pattern in winter (increased precipitation in the northern regions and decreased in the southern ones). The precipitation change patterns are generally consistent across different scenarios, being of largest magnitude in the A2 one.

The model performance in reproducing precipitation interannual variability varies across seasons, regions and differs between the CMIP3 and PRUDENCE ensembles (not shown). In DJF the CMIP3 models underestimate variability throughout Europe, while the PRUDENCE models overestimate it the Mediterranean and underestimate it over central Europe. In JJA the PRUDENCE models show a general underestimate over the CECILIA area while the CMIP3 show a more varied signal. Analysis of the change scenarios reveals a projected dominant increase in the summer and a smaller and more mixed signal in the winter.

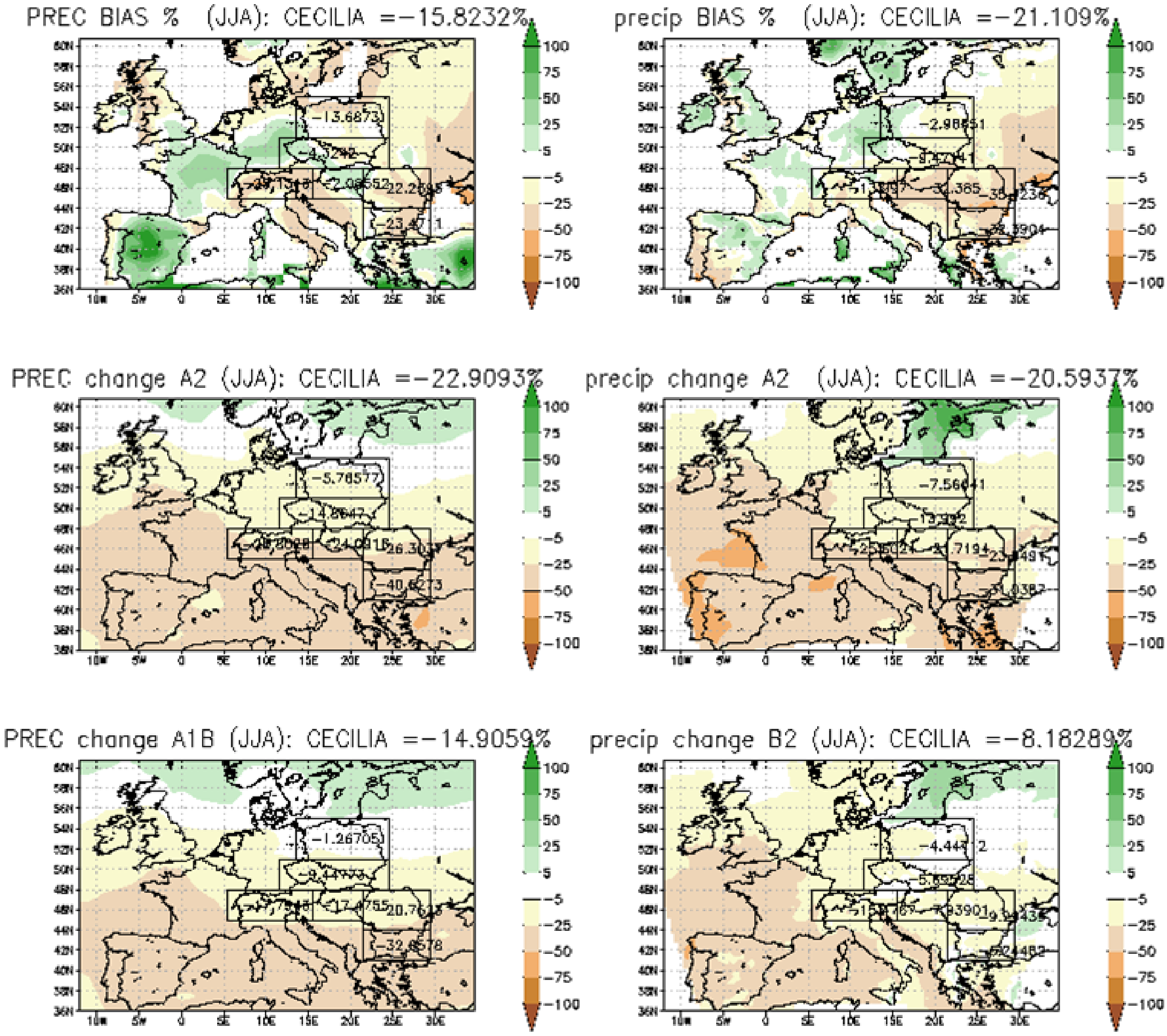


***Figure 9:** As figure 6 but for JJA mean precipitation.*

As an illustration of a second type of analysis, Figs. 10-11 show for the Alpine CECILIA region the trends in temperature and precipitation seasonal anomalies (with respect to 1961-1990) for the 20th and 21st century simulations in both the CMIP3 AOGCM and PRUDENCE RCM ensembles. Also reported are the observed anomalies for the 20th century period (from the CRU dataset). For the 21st century projected anomalies for different IPCC SRES scenarios are reported (A1B, B1 and A2 in the CMIP3 dataset, A2 and B2 in the PRUDENCE dataset).

It can be seen that the CMIP3 ensemble captures the observed 20th century warming and simulates warming in the range of 1°C to 6°C by 2100, maximum (minimum) in summer (winter) and in the A2 (B1) scenario (Fig. 10). The warming values simulated by the PRUDENCE ensemble are in line with those of the CMIP3 ensemble. Concerning precipitation (Fig. 11), observations show negligible trends during the 20th century in all seasons except for summer, when a slightly negative trend is found. This is captured by the models. The projections indicate the positive precipitation trend in winter and the negative trends in the other seasons, with these

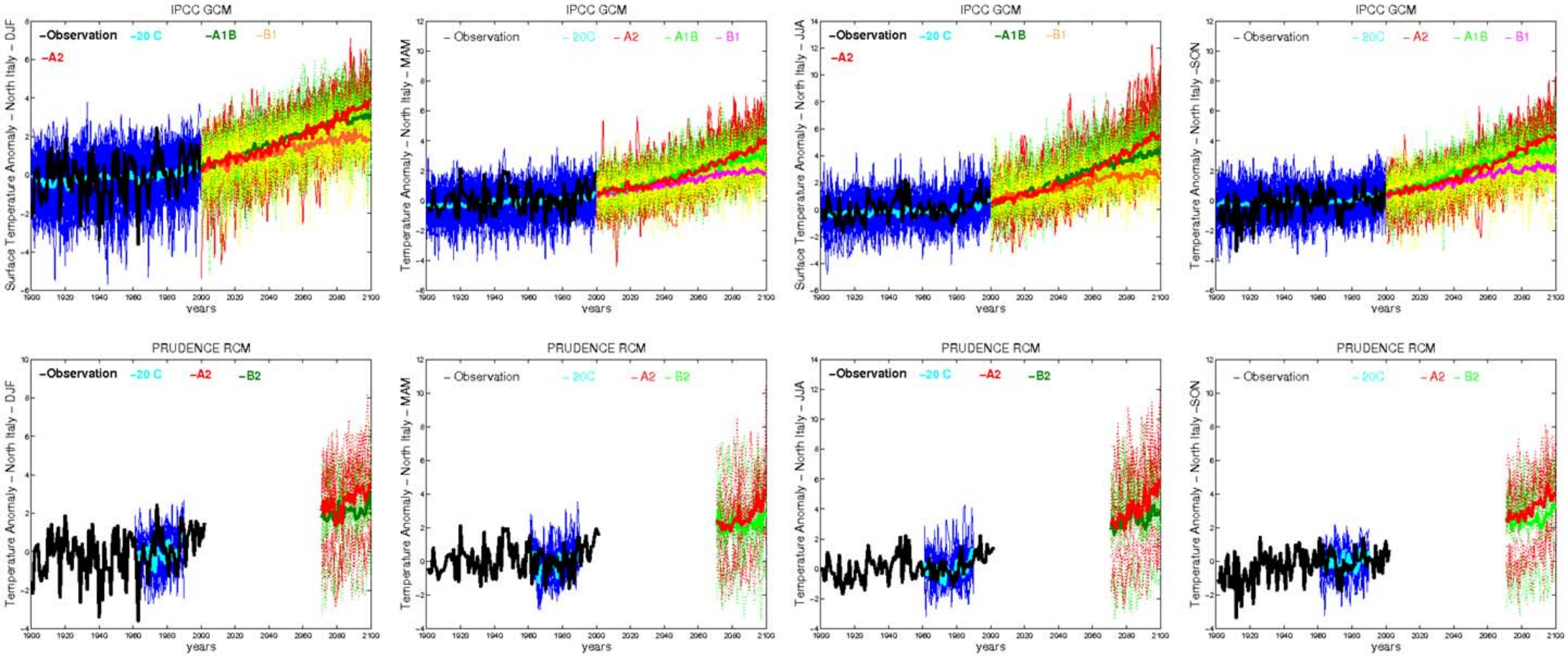


Figure 10: *Temporal trend of seasonal surface air temperature anomalies (compared to 1961-1990) for the 20th and 21st century over the Alpine CECILIA region in the CMIP3 (upper four panels) and PRUDENCE (lower four panels) ensembles.*

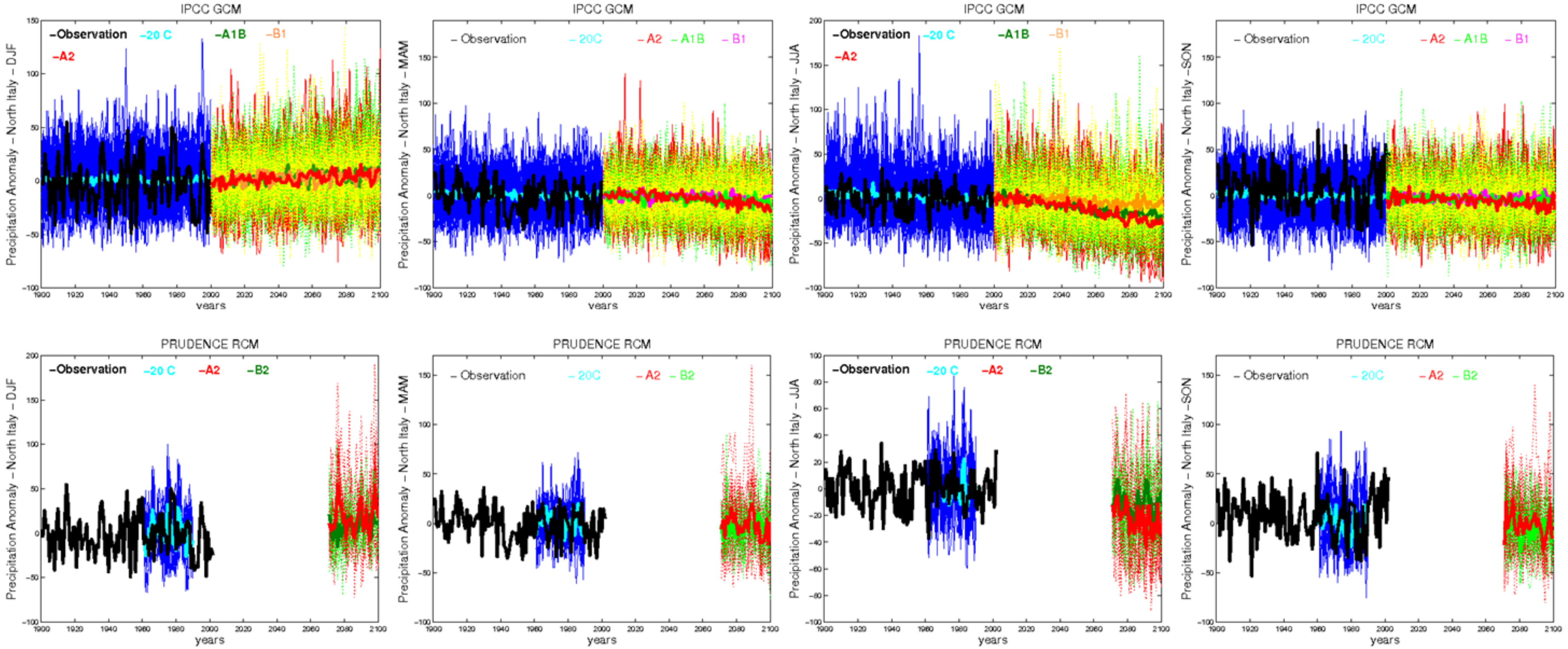


Figure 11: *Same as figure 10 but for precipitation in the Alpine CECILIA region.*

trends being consistent across scenarios. A similar analysis of observed and projected trends was performed for the other CECILIA regions and for interannual variability.

All the CMIP3 and PRUDENCE data collected for this assessment are stored in an ICTP server and are available to the CECILIA community for first stream impact assessment analysis. Subsets of these datasets can be easily extracted for specific applications. Since the ENSEMBLES scenario simulations are not yet available, they have not been collected and assessed.

ICTP also completed 50 km and 25 km 40-year long simulations driven by ERA40 reanalysis fields as part of the ENSEMBLES project and made available these datasets to CECILIA users for the provision of lateral boundary conditions in high resolution RegCM test runs. ICTP is also completing a scenario run with RegCM at 25 km grid spacing over Europe (A1B scenario with lateral boundary conditions from ECHAM5 large scale fields). About 60 years of this experiment have been carried out and it is planned to complete the experiment by month 18, as planned.

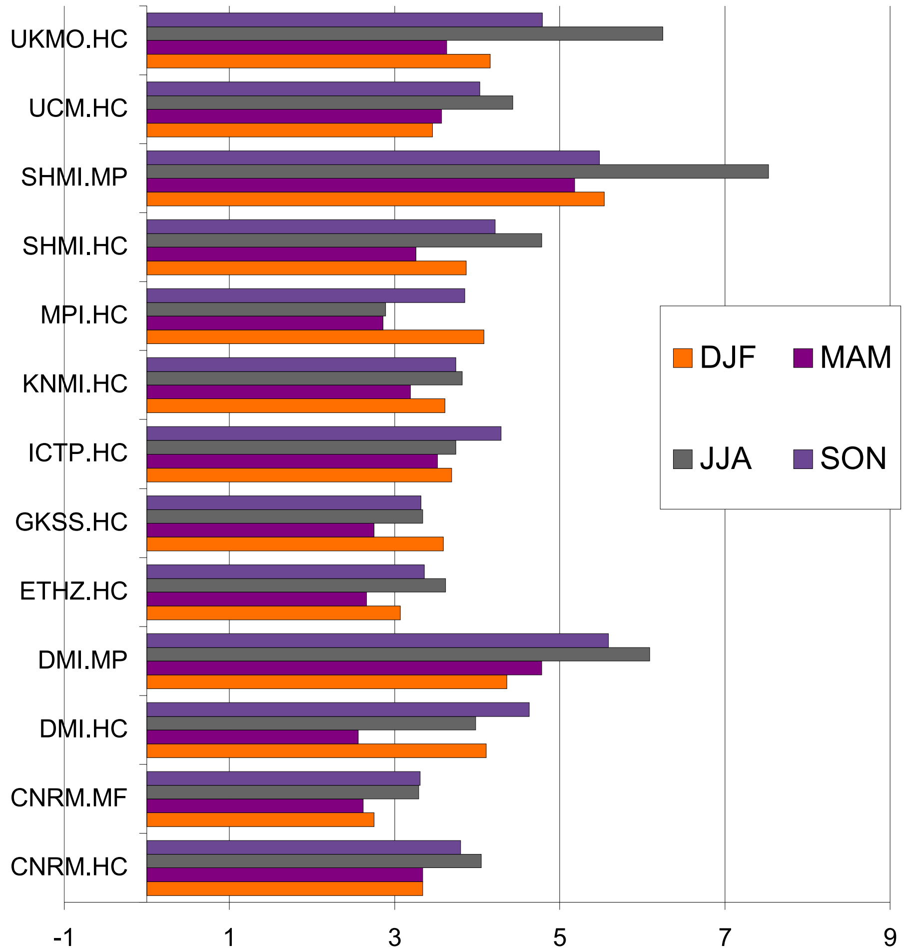


Figure 12: *Temperature response (°C) of the PRUDENCE A2 simulations over the Czech Republic for the four seasons.*

The main activity of CNRM was targeted to the production of Deliverable D8 alias D1.2, consisting of the provision of targeted climate change information from previous projects for first-stream impact work. Different information is available to test the impact models on targeted regions of Central and Eastern Europe. The most recent is the CMIP3 database, but the coarse temporal and spatial resolution makes it difficult for use in impact part of our project. Regional simulations, based on CMIP3, produced in the FP6-ENSEMBLES project are of greatest interest, but as mentioned they are not yet available. The best tool to start and validate the impact studies is the FP5-PRUDENCE database. Its resolution is daily and 50 km, which is closer to what needed for CECILIA. The fields are in free access through the web (with possibility of extraction before downloading).

There are eleven regional models in the database (including a post-project participant). In order to help selecting one or several models for a targeted application, averages for each country of the region (according to the political boundaries at 50 km resolution) have been calculated: Austria, Bulgaria, Czech Republic, Hungary, Poland, Romania and Slovakia. The model systematic errors for each season, as well as the model responses for each model and each scenario (SRES-B2 and SRES-A2) are provided in tables for temperature and precipitation. Fig. 12 shows, as an illustration of the content of this deliverable, the temperature increase in the 13 PRUDENCE simulations of the A2 scenario over the Czech Republic. Most models agree with a maximum warming in summer.

ETH provided an analysis of pre-existing regional climate model simulations from the PRUDENCE project (Hirschi et al. 2007) focusing on the validation and the analysis of terrestrial water storage in an ensemble of RCMs and its links to other processes. For the analysis, a diagnostic basin-scale water-balance dataset of terrestrial water storage variations has been applied. It has been shown that the biases of the models in terrestrial water storage are closely related to biases in other hydrological fluxes (i.e., precipitation, runoff, evapotranspiration). Moreover, all models suffer from a considerable underestimation of inter-annual terrestrial water storage variability.

2.1.3 Deviations from workprogramme

All the requirements of milestone M1.1 were achieved, both the deliverables D1.1 and D1.2 were delivered in due time. No deviations from the plan expected.

2.2 WP2

2.2.1 Workpackage objectives

The main objective of WP2 is to produce simulations on targeted domains for a past period (1961-1990) driven by ERA40 reanalysis, as well as for a reference period (1961-1990) and two GCM driven scenario time slices (2021-2050 and 2071-2100) based on AR4-A1B GCM projections. Two models have been supposed to be used aiming primarily at producing high resolution (10 km) climate change scenarios over four target areas, ALADIN-Climate family using stretched climate change transient run by ARPEGE/Climat for ENSEMBLES project, RegCM family using RegCM transient ENSEMBLES run for whole EUROPE in 25km resolution driven by transient run of ECHAM5. While the stretched ARPEGE run provides reasonable resolution in targeted regions for direct application of 10 km resolution RCM, the difference between 10 km resolution of RegCM and the resolution of other common global models is to large, that is why the double-nesting using 25 km RegCM run is necessary. The daily data from the simulations will be put in a common database.

Beside this primary task the validation of basic characteristics is supposed as well in framework of preliminary tests. More detailed validation and analysis of parameters used for impact applications was scheduled in WP3 and 4 later on, the model responses are to be compared with coarser results from existing simulations to assess the gain of a higher resolution. Another objective is the test of improved physical parameterizations better suited for 10 km horizontal resolution, based on the simulations results when some problems or possible improvement identified. This will provide the information on further development of the models for very high resolution, unfortunately, due to time limited for delivery of the results to the impact studies our major simulations cannot benefit from these experiments.

2.2.2 Progress towards objectives

In the first year of the project, there was a single milestone M2.1 due month 6: The integration domains and RCM parameterizations are defined. This milestone has been reached in due time, and now, the 6 models have defined their integration area. Note that OMSZ and ELU share the same domain. The parameterizations for the 3 RegCMs and the 3 ALADINs have been defined so that the integrations have been able to start. There is no deliverable in this workpackage for the first year.

WP2 leader CNRM was active organizing the start of the preparatory work for the tasks to be solved. CNRM is mostly in charge of providing lateral boundary conditions to the ALADIN models from the ARPEGE/Climat global variable resolution model. This model has a resolution of 50 km over Europe, whereas the ALADIN models have a 10 km resolution. In order to facilitate the exchange of data and allow some flexibility to the partners to define their own integration domain, it was decided to prepare a large domain covering the three ALADIN targeted domains. This big ALADIN domain (named CEC50) has a resolution of 50 km. The partners have a tool (ARPEGE/IFS/ALADIN configuration 927) to interpolate from CEC50 to their own domain. The alternative solution would have been to go directly from ARPEGE global grid to the 3 ALADIN domains (at 10 km resolution) with huge data transfer and no possibility to extend the domain. Fig. 13 shows the grid points of this pan-CECILIA domain. Six-hourly data of the 1960-1990 and 2020-2050 have already been interpolated from ARPEGE grid to CEC50 grid.

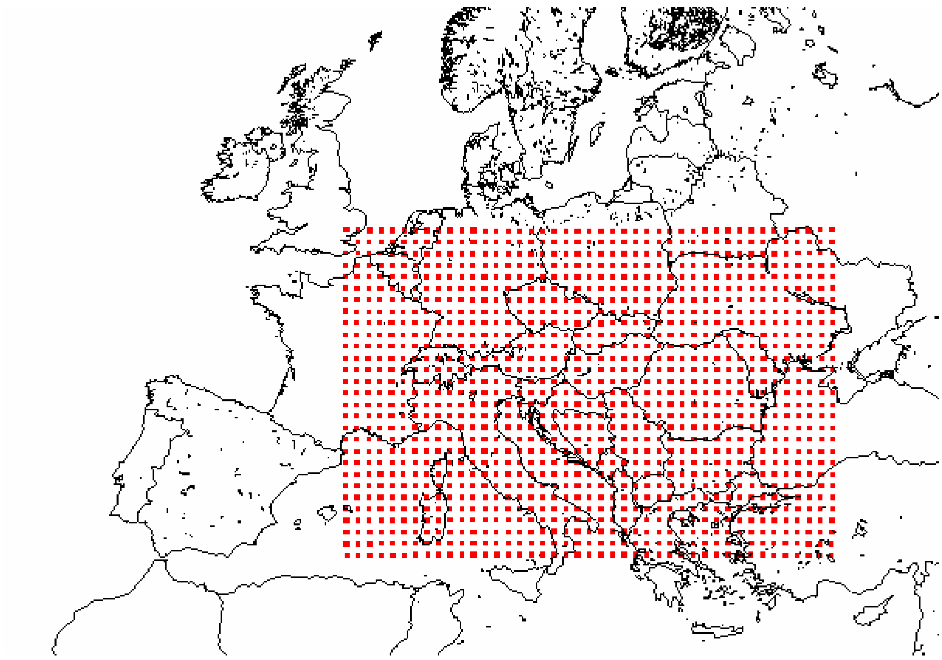


Figure 13: *Grid points of the pan-CECILIA domain*

In framework of coordinating role of CNRM in WP2 modeling activity one question raised was the choice of the way to drive ALADIN (10 km) with ERA40 data (120 km). One possibility is direct forcing, with the risk of high jump in resolution at the lateral boundaries. The other possibility is the two tier approach with an intermediate resolution (e.g. 50 km) simulation. This approach has an additional cost, and the risk of error accumulation at each step. In order to better document the risk of resolution jump, we have defined an ALADIN model with 10 km resolution over France. This model is similar to the models used in CECILIA. A coarser resolution (50 km) of this model was derived. Both models were driven by ERA40, exactly like in CECILIA. When averaged over the same 50 km mesh grid, the two models present very similar features in their climatologies of temperature and precipitation. Fig. 14 shows for winter and summer the differences for temperatures.

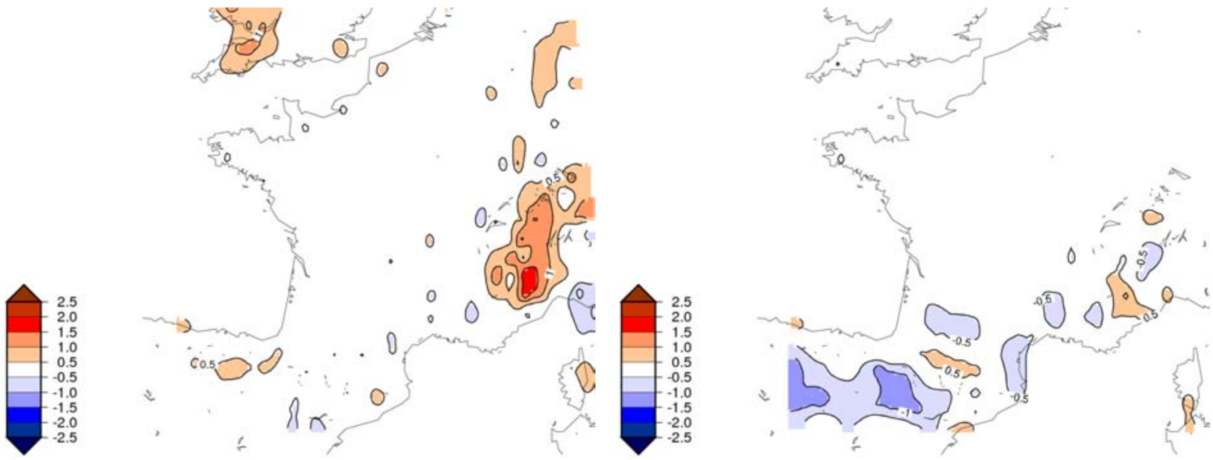


Figure 14: *Temperature differences (°C) between ALADIN@10 km and ALADIN@50 km simulations driven by ERA40 for DJF (left) and JJA (right) when the integration domain is France. Details below 50 km are filtered.*

Beside CNRM another partner, ICTP provided their results from ENSEMBLES based on ERA 40 for RegCM models used in CECILIA project as driving fields for high resolution experiments and test. In addition, they started to prepare the time slices data from transient climate change experiment for ENSEMBLES. For sharing all these results as well as the final CECILIA results, DMI participated in definition of the content of the CECILIA database and prepared its establishment in their server. Moreover, using their expertise, DMI contributed by the concertation with the partners about the choice of model and the choice of domain size.

For the M2.1 all the integration domains for individual partners involved in RCM simulations in targeted regions were settled as shown in Fig. 15. Some parameters of the individual domains as well as specification of the model used are summarized in Tab. 1, more details see below in connection with the description of preliminary experiments.

Table 1: *Individual model specifications*

partner	model	resolution	domain size	domain location (centre)
CUNI	RegCM	10 km	184 x 164 x 23	49.0 N, 15.8 E
CHMI	ALADIN-Climate	10 km	160 x 102 x 43	48.52 N, 17.27 E
NMA	RegCM	10 km	156 x 102 x 18	46.0 N, 23.5 E
NIMH	ALADIN-Climate	10 km	105 x 80 x 31	42.5 N, 25.0 E
OMSZ	ALADIN-Climate	10 km	94 x 72 x 18	47.5 N, 18.5 E
ELU	RegCM	10 km	94 x 72 x 18	47.5 N, 18.5 E

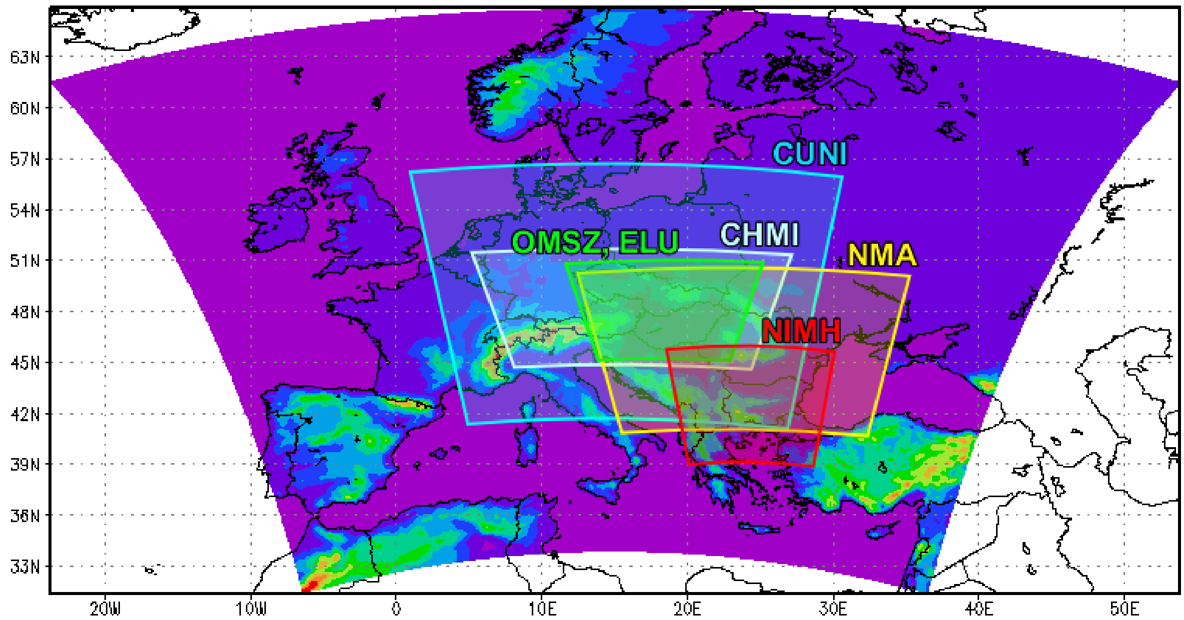


Figure 15: *Integration domains for individual partner simulations*

As for parameterization used by CUNI, default setting of RegCM3 is used. The model RegCM used here was originally developed by Giorgi et al. (1993a,b) and then has undergone a number of improvements described in Giorgi et al. (1999), and, finally, Pal et al. (2005). The dynamical core of the RegCM is equivalent to the hydrostatic version of the mesoscale model MM5. Surface processes are represented via the Biosphere-Atmosphere Transfer Scheme (BATS) and boundary layer physics is formulated following a non-local vertical diffusion scheme (Giorgi et al. 1993a). Resolvable scale precipitation is represented via the scheme of Pal et al. (2000), which includes a prognostic equation for cloud water and allows for fractional grid box cloudiness, accretion and re-evaporation of falling precipitation. Convective precipitation is represented using a mass flux convective scheme (Giorgi et al. 1993b) while radiative transfer is computed using the radiation package of the NCAR Community Climate Model, version CCM3 (Giorgi et al. 1999). This scheme describes the effect of different greenhouse gases, cloud water, cloud ice and atmospheric aerosols. Cloud radiation is calculated in terms of cloud fractional cover and cloud water content, and the fraction of cloud ice is diagnosed by the scheme as a function of temperature. Our setting of convection is Grell scheme with Fritsch & Chappell closure scheme. For more details on the use of the model see Elguindi at al. (2006).

In framework of work on D2.1 CUNI has started the simulation based on reanalysis, both directly from ERA40 and, due to the too big step between ERA40 resolution (more than 100km) and RegCM planned resolution of 10 km, from RegCM reanalysis run of ICTP for ENSEMBLES project in 25 km. Preliminary results presented in Fig. 16 show the comparison of surface temperature for selected grid points and station measurements (with approximately similar topography height) for first six years of the simulation (1961-66). The advantage of the double nesting can be seen, it looks to be general feature of the simulation. More detailed analysis for the first decade will be provided later when completed.

Another partner using the RegCM3 model is NMA. The model has been prepared for implementation on a PC Linux Cluster (7 nodes, 17 processors dual, available operationally on June) and first tests started. We tested for the time being two versions, bot with 18 vertical levels. Small domain of 104x102 points was centered on 46N,25E, and a bigger domain of 156x102 points on horizontal centered on 46N,23.5E, as seen in Figs. 17 and 18 where the results of test simulations shown for precipitation and temperature, respectively. A second test was done for convection parameterization, Grell scheme (Figs. 17c, 18c) compared to Emanuel scheme (Figs. 17e, 18e). A third experiment was conducted to test the double nesting (get a smoother resolution increase from ERA40 2.5 deg to 10 km), and a fourth test was done to assess the effect of aerosol forcing. The simulation takes 24 hours for one year on this project dedicated machine.

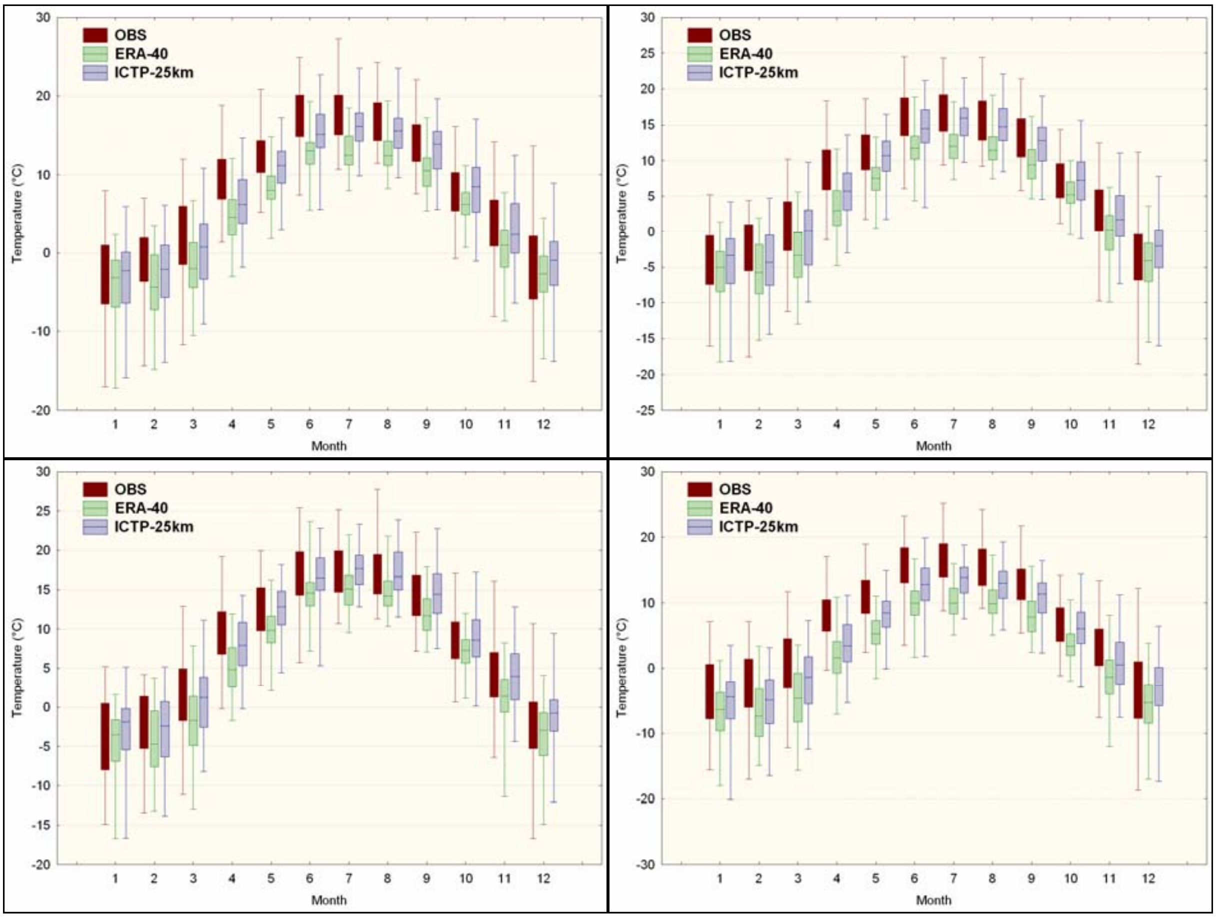


Figure 16: *Simulations driven directly by ERA40 and ICTP25km run based on ERA40 vs. stations measurements for Zatec (upper left), Havlickuv Brod (upper right), Holesov (bottom left) and Husinec (bottom right), mean daily temperature.*

Results were preliminary compared against CRU data for total precipitation (Fig. 17b for small domain and Fig. 17d for big domain) and 2m temperature (Figs. 18). Precipitation field is overestimated mainly over steep topography, and additional tuning for LBC effect on precipitation (vertical velocity) is needed. The 2m temperature presents a too small meridional gradient that might impact on a lower zonal wind connected to evaporation/convection at sea/land areas which should be further investigated. These experiments are very preliminary and not yet conclusive, but we can notice improvement when increasing the domain both for 2m temperature and especially for precipitation. This might be connected to the lateral boundary effect that impacts more on the smaller domain. For our domain Grell convection scheme seems to approach better the observed pattern and to less overestimate it. We cannot take any conclusion from the aerosol forcing effect for now, apart a very slight improvement for the short experiment (autumn season) done. Double nesting, for the period tested does not bring a relevant improvement (in the same time being more costly). We intend to make one longer test in order to confirm the need of work on LBC specification.

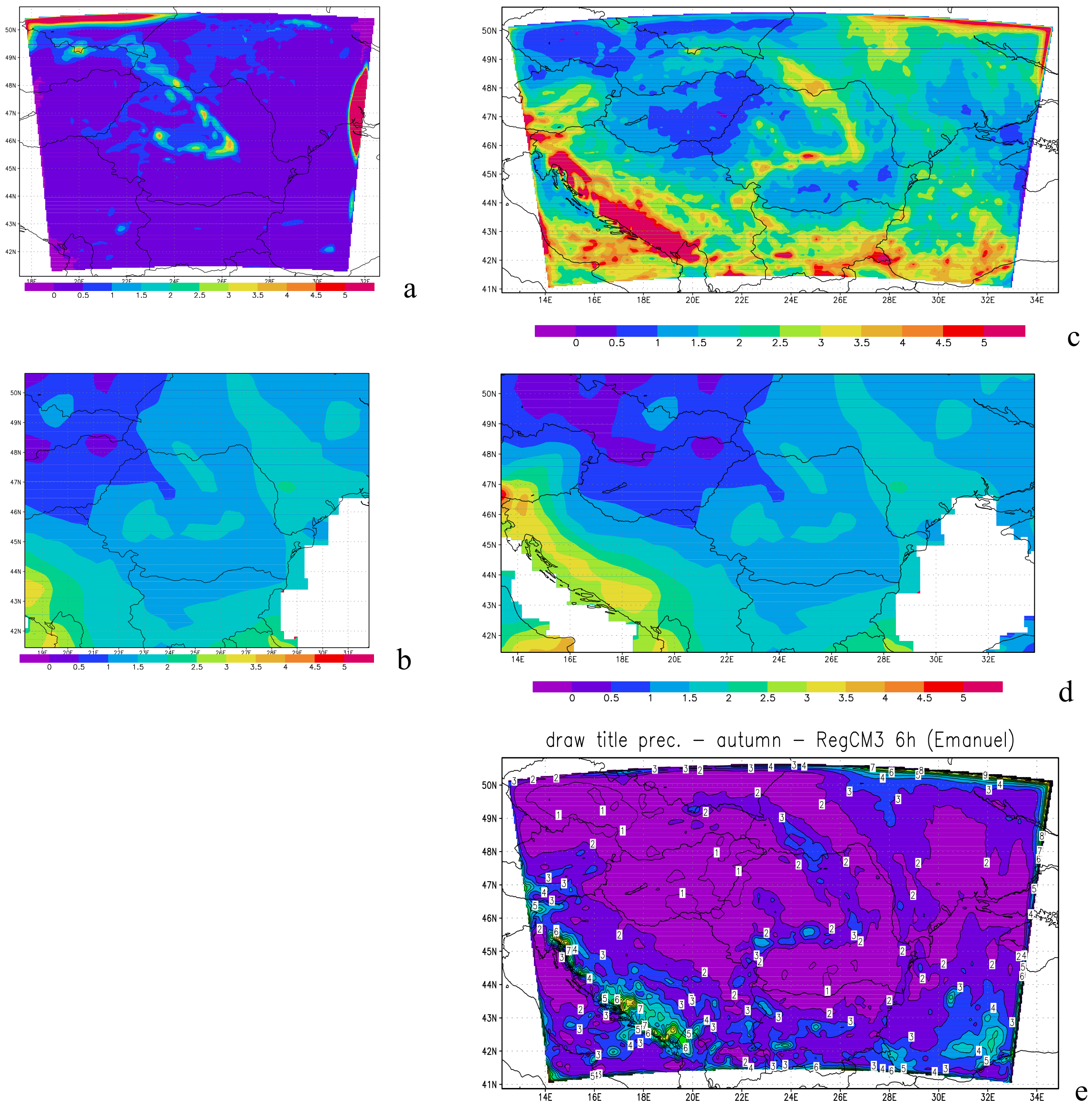


Figure 17: *precipitation mm/day average over season, autumn (SON 1959-1960) a) Regcm simulation small domain, Grell, b) CRU data, c) Regcm simulation big domain , Grell d) CRU data big domain and e) Regcm simulation big domain, K. Emanuel*

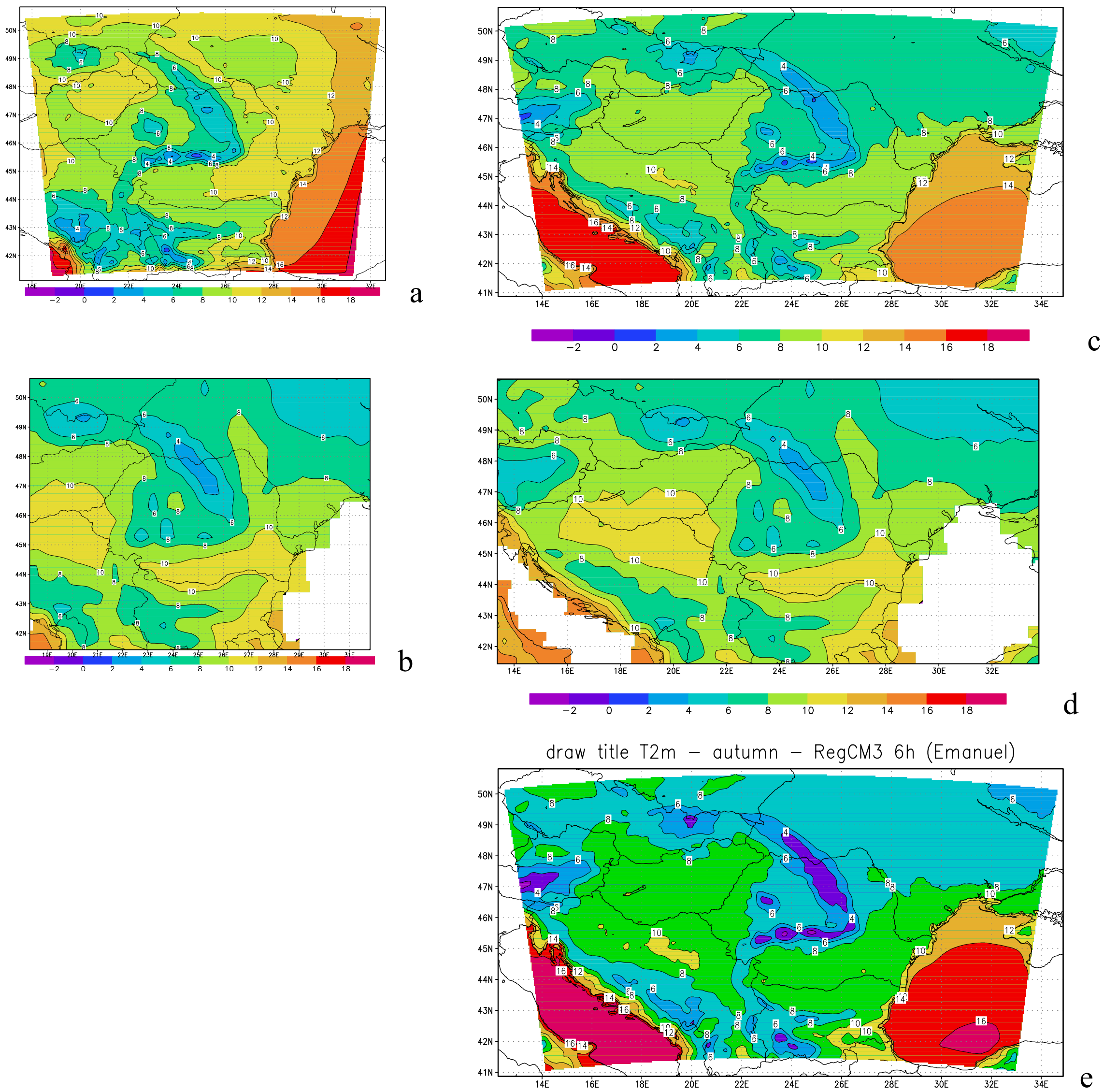


Figure 18: *As Fig. 17 for temperature 2m (°C)*

Another partner running regional climate model RegCM to simulate the climate of the Carpathian basin using three time-slices as agreed with the other partners involved in the project is ELU. In the mean time, the other Hungarian partner, the Hungarian Meteorological Service (HMS), selected regional model ALADIN to make simulations for the same region. Thus, comparison of the two RCM results is possible for the Carpathian basin. For the Milestone M2.1 by month 6, ELU and OMSZ agreed on the central domain of simulations (excluding the buffer zones for the RCMs) using both RegCM and ALADIN (Fig. 19). The geographical location of the central domain can be characterized by the following four corners (Table 2), and the central point of the domain:

Table 2: *parameters of the ELU domain.*

SW	45.20°N	14.00°E
SE	45.15°N	23.10°E
NW	49.75°N	13.35°E
NE	49.70°N	23.55°E
Center point	47.5°N	18.5°E

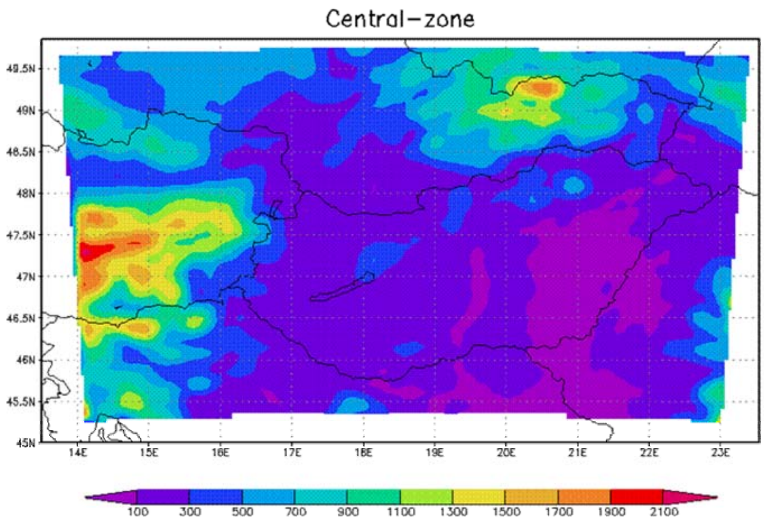


Figure 19: *Spatial extension of the main domain for RegCM and ALADIN*

Several test simulations were accomplished for the 1960-1990 period in order to choose the best parametrization schemes, and other conditions used with RegCM optimized for the selected domain. As NMA partner it was the case of different convective parameterizations test at 10 km horizontal resolution, Emanuell scheme has been compared to Grell (Fritsch & Chappell closure) scheme. Different number of vertical levels (both convective schemes, 10 km horizontal resolution) was tested as well with all predefined options, i.e. 14, 18 and 23 vertical levels. To estimate the efficiency of the runs, different temporal resolutions of 20 and 30 sec with Emanuell scheme, both for 18 and 23 vertical levels, at 10 km horizontal resolution were tested. Benefit of higher resolution was analysed testing the simulation based on ERA-40 / 1° res., with Grell scheme, 18 vertical level, at spatial resolution of double nesting at 45 km and 10 km afterwards, as well as direct nesting at 20 and 10 km resolution. To obtain some information on sensitivity to model domain size the same setting (Emanuell scheme, 18 vertical levels, 10 km horizontal resolution) was used with central point: 47.5°N, 19.5°E for 94 × 74 gridpoints, and 110 × 90 gridpoints and 140 × 120 gridpoints.

At the Hungarian Meteorological Service (OMSZ) the preparations for the ALADIN/Climate model integrations had been started. The main concern of these preparations were the determination of the proper domain for the CECILIA integrations. On the one hand discussions and adjustments were carried out with the Eotvos Lorand University and on the other hand some comparative tests were realised with 10km and 25km versions of ALADIN for a 10 years period of 1960-1969. The main objective of the latter comparison was to see whether the integrations for the high resolution small domain give also reasonable results compared to the 25km version with bigger domain size (the outputs of both models were verified with respect to the CRU datasets). The results advocate (Fig. 20) that the small, but higher resolution domain results seem reasonable, therefore that domain can be used in the later stage for CECILIA simulations (Fig. 21).

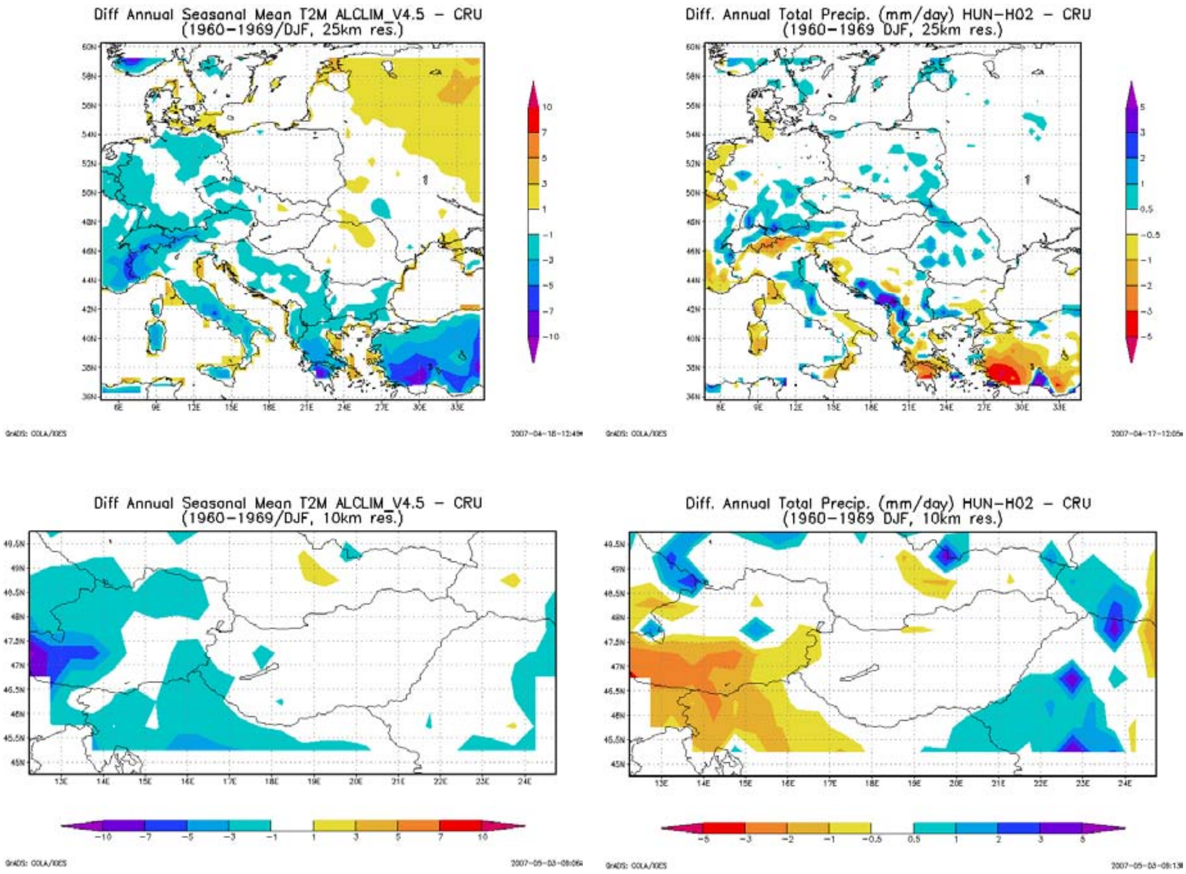


Figure 20: *Comparison of ALADIN/Climate simulations for 25km and 10km resolutions with bigger and smaller domains respectively. On the top the 25km simulations and on the bottom the 10km resolution simulations can be seen. Left: mean temperature, right: mean precipitation for the winter period compared to the CRU data.*

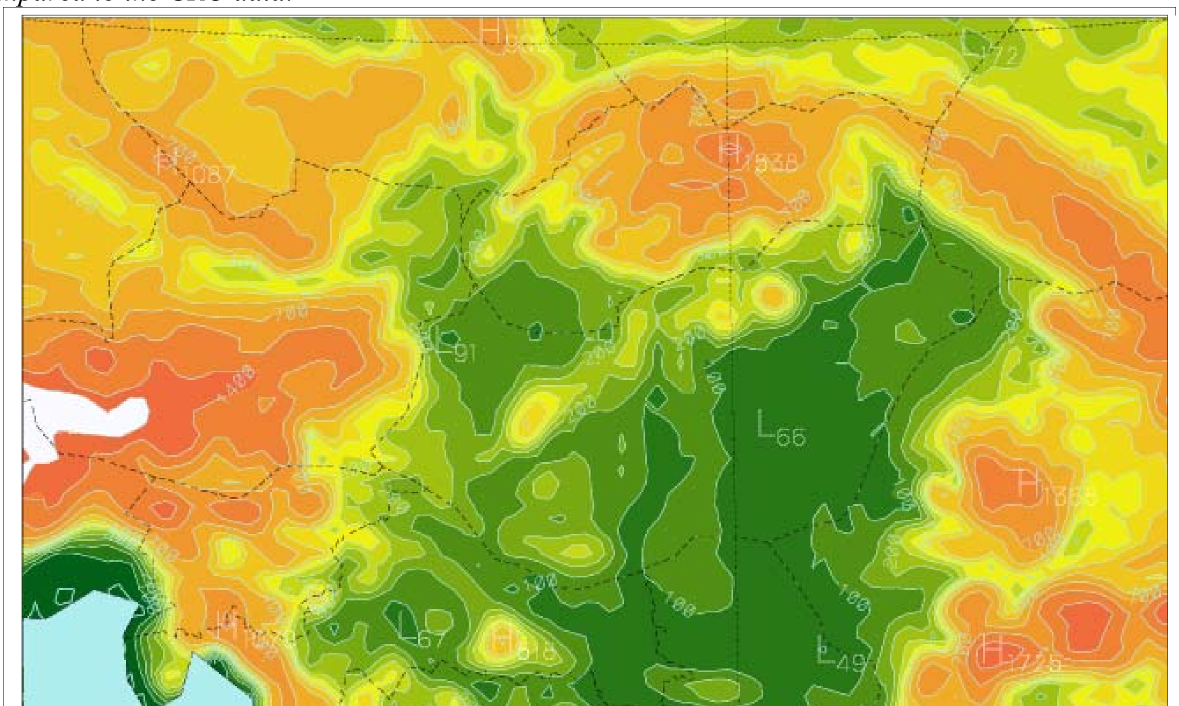


Figure 21: *The domain and orography of ALADIN/Climate for the CECLIA integrations*

At CHMI, in accordance with WP2 timetable during the first project year most effort has been focused on development of ALADIN-CLIMATE/PRG version of model. The work devoted to this goal was simplified by parallel work on ENSEMBLES project which also focuses on improvements in model performance. Nevertheless, even though model ALADIN performed well in previous experiments in 50 and 25kilometers resolution, some new problems appeared when making experiments in 10 kilometers resolution which have compelled us to investigate their causes and to look for appropriate counter-measurements. During the first phase of the year, preliminary integration area was selected and tested in accordance with milestone M2.1. Short time (1 month) integrations were executed to assess the overall cost of integrations in frame of CECILIA project and to evaluate its feasibility with respect to other duties being carried out at CHMI central computer (e.g. numerical weather forecast). The actual configuration of model covers integration area (C+I) 192 x 102 points with spatial resolution 10 km and 43 levels. With time step of 450 s this configuration consumes 6-7 hours of CPU time per model-month at NEC SX6.

Concerning the scientific point of view direct coupling with ERA-40 in its native resolution has been tested and compared to "nested" approach when an intermediate step in coupling process has been introduced: 10 kilometer resolution experiment has been driven by 25km resolution ENSEMBLES ERA-40 experiment and not directly with ERA-40 data. Additionally, coupling of ALADIN-CLIMATE/PRG with ARPEGE/CLIMATE present climate run has been tested to detect possible problems and caveats during the whole process. Resolution of 25km has been used because of availability of such a data from related ENSEMBLES experiments allowing us more straightforward evaluation of obtained results. During the second half of the year test integration has been launched to verify overall model performance when operating in 10 km resolution. Unfortunately, some unfavorable development has been detected when evaluating obtained results leading to an effort to explain reasons by assessing influence of more distinguished potential causes (e.g. influence of latest parameterizations changes, resolution + domain extension or coupling technique – direct approach counter "nested" one). This work is still in progress. Additional care has been aimed on investigating of model output quality in areas important for impact modelers community. Particularly snow cover and diurnal temperature range field has been matter of interest. In near future a more thorough investigation of more ALADIN surface fields is supposed in cooperation with WP6 CHMI team from regional office in Brno.

Another region for CECILIA integration is centred above the Bulgarian territory and covered by the ALADIN model run at NIMH. Preliminary tests with ERA40 data were made using direct transition from 1.5 deg. (~120 km) horizontal resolution (60 vertical levels) of ERA40 data to 12 km horizontal resolution (31 vertical levels) was experimented. The reason of that was not only economy of computation time but the fact that it is unlikely to obtain some real signals only by using intermediate interpolation. We used the integration domain of the Bulgarian-ALADIN operative version. The South-West corner is at 39.8deg/20deg and the North-East one at 46.4deg/31.6deg. It is illustrated in Fig. 22. The synoptic stations used for evaluation are shown in the same figure. The model runs 10 year period starting from 1990.

For validation of the model comparing 2m temperature measurements against the model result we used we used the *'best correlated'* neighbour grid point from 4 surrounding points for each station. This localization technique attempts to reduce the effect of the discrepancy between the model 'land use' field and the real one. Any interpolation of the surrounding grid points may use points over different land cover (see, forest, snow area, etc., especially in the complex terrain). Fig. 23 shows the correlation between the stations and the nearest gridpoint. Considering 2m temperature validation against observations it seems that reasonable downscaling up to 10 time's finer resolution could be obtained by regional climatic models. Moreover, other tests showed that ERA40 re-analyses give realistic opportunity for verification even over area with complex topography and terrain.

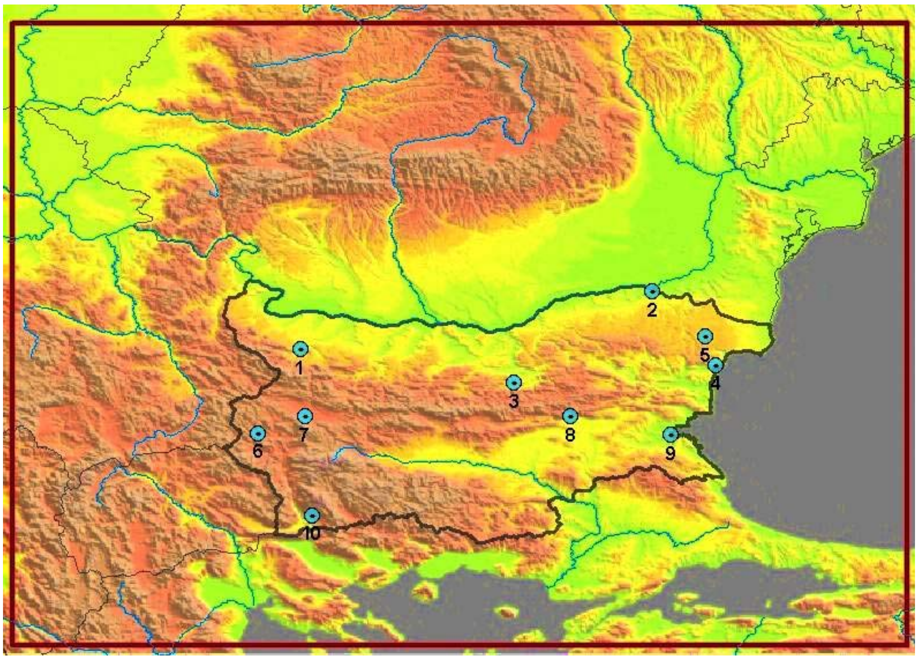


Figure 22: *Location of the synoptic station on the domain*

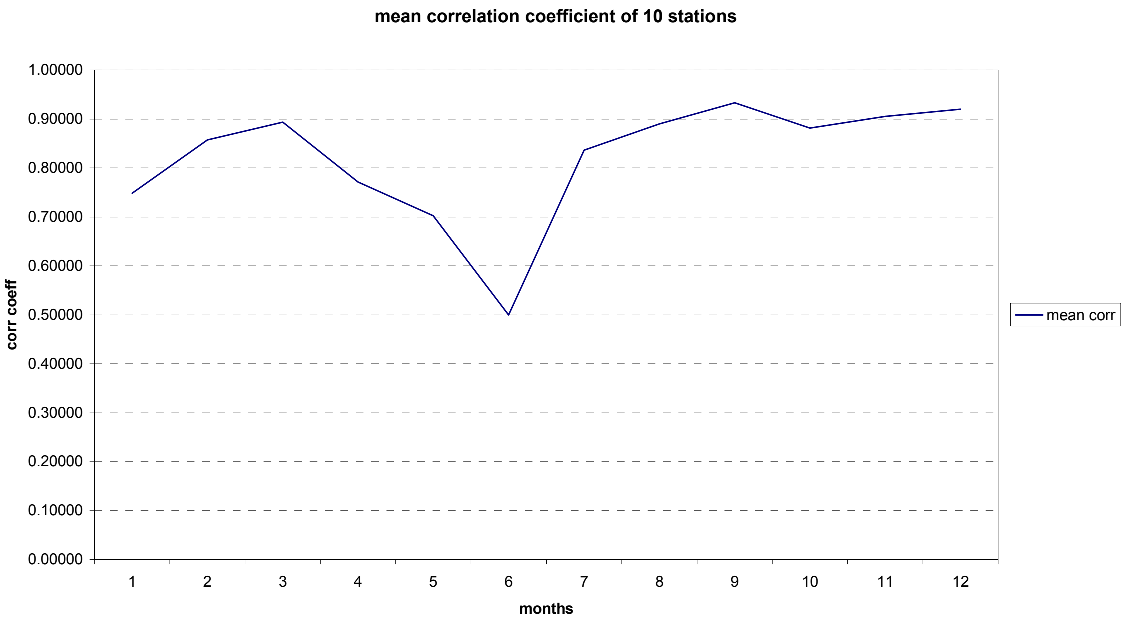


Figure 23: *Correlation between 10 years monthly mean model and observed temperature.*

As mentioned above, another important task of WP2 is to study the possible improvements of the RCMs for this very high resolution. In addition to the individual CECILIA regions tests AUTH is performing the comprehensive experiments to confirm the transferability and to validate the tests in more general region. Emanuel vs Grell (AS and FC closures) convective parameterizations in whole Europe simulations with RegCM3 were analysed. The simulations have been performed with a horizontal resolution of 60 km x 60 km over the greater European area for three individual years using three convective parameterizations, a) the Grell scheme with Arakawa-Schubert (AS) closure, b) the Grell scheme with Fritsch-Chappell (FC) closure and c) the Emanuel scheme. The comparison of the model results of surface temperature with Climatic Research Unit (CRU) gridded surface temperature observations indicates a cold bias with the Grell scheme (either AS or FC closure schemes) which is significantly reduced throughout the year when the Emanuel convective scheme is introduced (see Fig. 24). The temperature differences between the Grell (with either AS or FC closure schemes) and the Emanuel scheme dominate in the lower troposphere extending up to 700 hPa. As far as it concerns the total precipitation no systematical differences between Grell and Emanuel schemes are observed throughout the year for the European domain but the convective part of total precipitation is greater when Emanuel scheme is used. For the Central Eastern and South Eastern sub-domains, in general Emanuel scheme produces more precipitation during the warm season. It is evident that the cause of the differences between the convective schemes is due to a more intense convection in the Emanuel scheme which in turn imposes a more effective drying of the atmosphere, less low-level clouds, more SW solar radiation absorbed from the ground (see Fig. 25) and hence warmer low level temperatures.

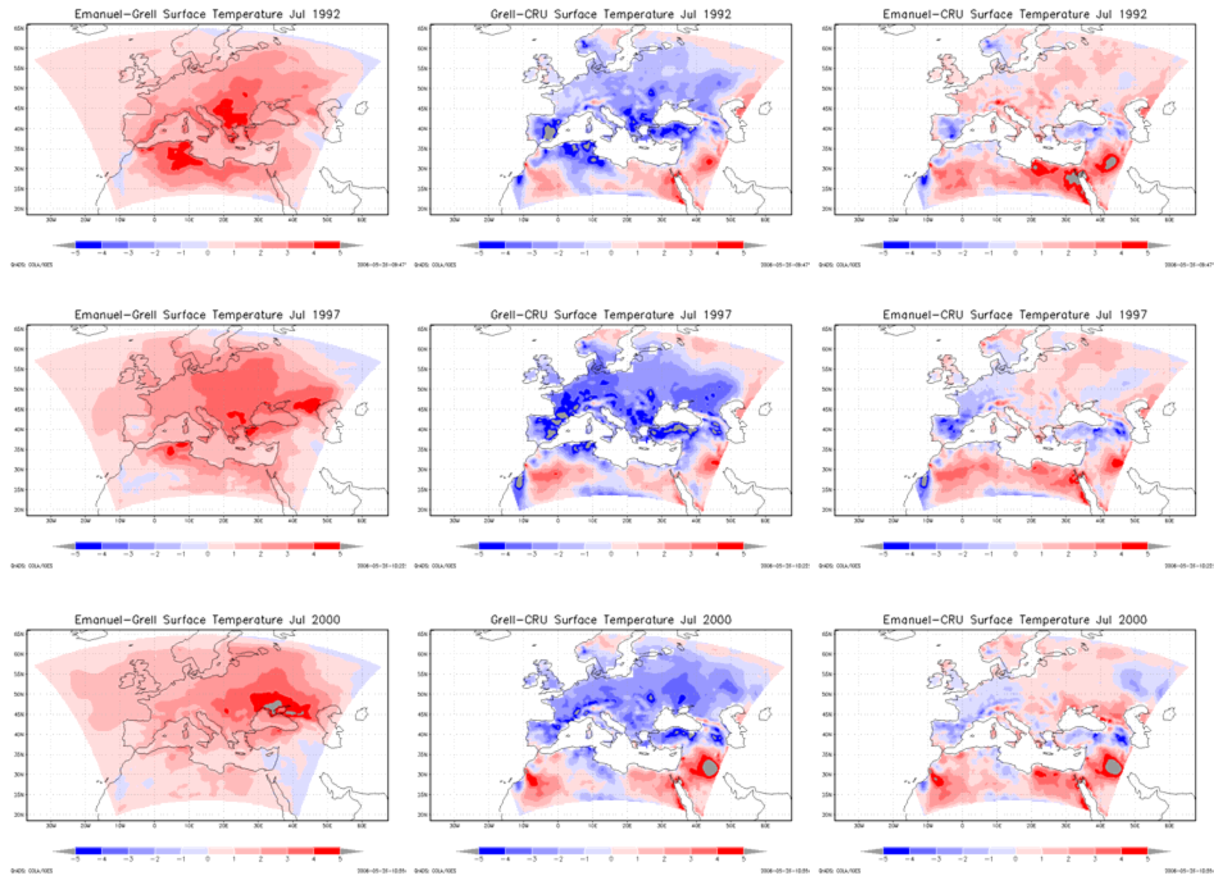


Figure 24: *Surface temperature differences; Left column: RegCM3 (with Emanuel)- RegCM3 (with Grell AS) for July 1992, 1997 and 2000. Middle column: RegCM3 (with Grell AS)- CRU for July 1992, 1997 and 2000. Right column: RegCM3 (with Emanuel)- CRU for July 1992, 1997 and 2000.*

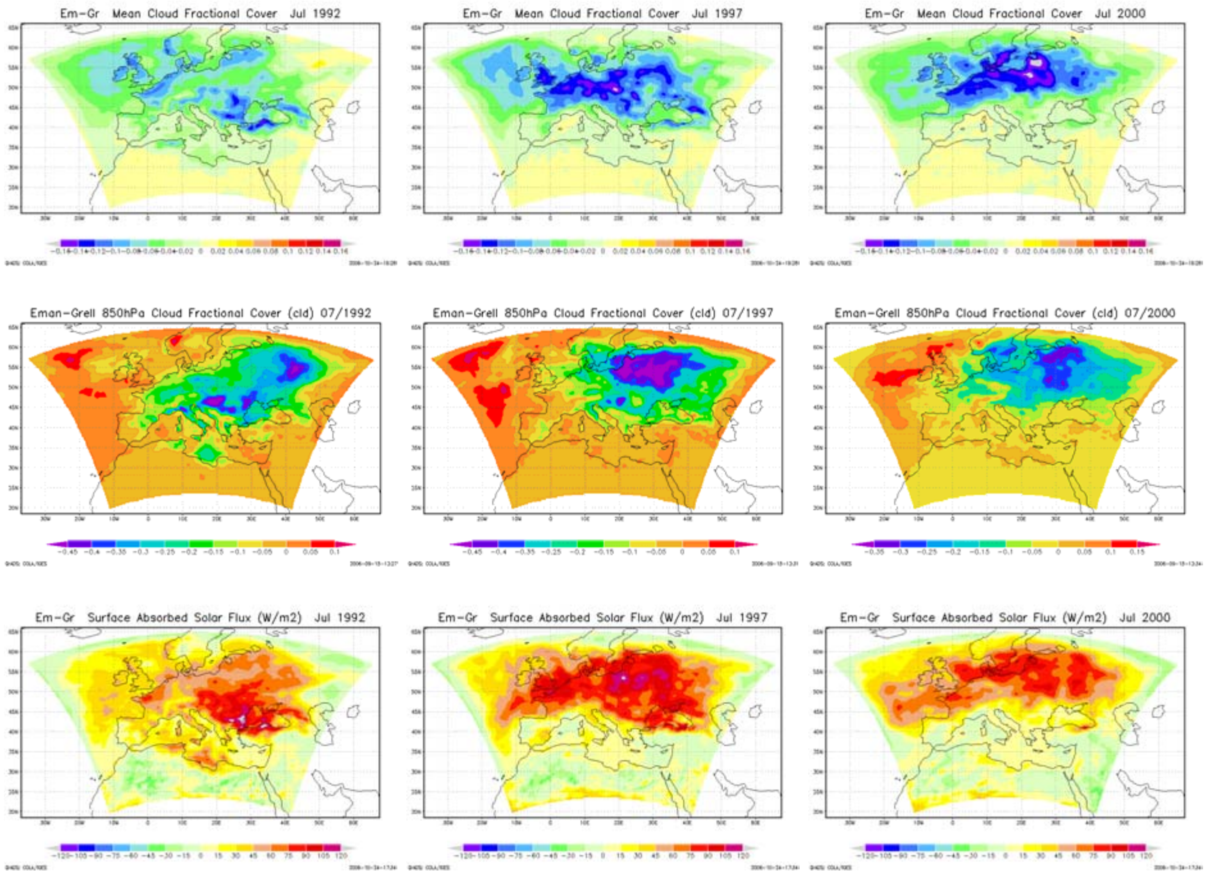


Figure 25: *Upper panel: Differences of total mean cloud fractional cover between RegCM3 (with Emanuel) and RegCM3 (with Grell AS) for July 1992, 1997 and 2000. Middle panel: Differences of mean cloud fractional cover at 850 hPa between RegCM3 (with Emanuel) and RegCM3 (with Grell AS) for July 1992, 1997 and 2000. Lower panel: Differences of surface absorbed solar flux between RegCM3 (with Emanuel) and RegCM3 (with Grell AS) for July 1992, 1997 and 2000.*

2.2.3 Deviations from the project workprogramme

According to the description of work, the next milestones are:

- M2.2 Month 18: The observation driven simulations are ready for other WPs
- M2.3 Month 24: The scenarios and references RCM simulations are ready for other Wps
- M2.4 Month 24: The sensitivity experiments to improved physical parameterizations are analyzed

and the corresponding deliverables:

- D2.1 Month 18: RCM simulations forced by observations M7-M18 (CUNI, CHMI, ELU, OMSZ, NMA and NIMH)
- D2.2 Month 19: forcing files from ARPEGE for the different versions of ALADIN M7-M19 (CNRM)
- D2.3 Month 19: forcing files from RegCM for the different versions of RegCM M7-M19 (ICTP)

- D2.4 Month 24: RCM simulations forced by models M13-M24 (CUNI, CHMI, ELU, OMSZ, NMA and NIMH)

There are at this stage no deviation from the workprogramme and the plans for next year of the partners are covering the milestones and deliverables above to be achieved.

Primary objective is to complete all the simulations to be available for impact studies in time. For this purpose, CNRM will achieve the 1950-2100 run with the global model ARPEGE (in WP1) and prepare/distribute forcing data on the CEC50 grid for the 3 periods 1960-1990, 2020-2050, 2070-2100. The first year of each 31-year period will be necessary to equilibrate the soil moisture in the ALADIN models. In the next 6 months ICTP will complete ECHAM-driven 150 year RegCM scenario simulation at 25 km resolution and provide the fields necessary to run the high resolution CECILIA experiments.

As for high resolution simulations in CECILIA targeted regions CUNI will run the control and scenarios time slices simulations driven by ICTP RegCM@25km run based on ECHAM A1B scenario run in parallel, once the ERA40-driven simulation is validated preliminary for the first decade. Similarly, NMA and ELU will use the same data for RegCM runs on the Romanian and Hungarian domains, respectively, when available, still after some analysis and further tuning of the models based on reanalysis runs.

Using ALADIN/Climat some more small modifications are supposed to be tested by CHMI to avoid problems encountered in mode of long-time integrations. Changes should secure smooth executing of experiments and ameliorate problems resulting from conflicts with NWP runs. Then, running the ERA40 driven simulations, as well as ARPEGE driven simulations will be done in parallel and produced in due time. NIMH will install version 4.6 of ALADIN/Climat on their new computer and run the ERA40-driven simulation, as well as the three ARPEGE-driven simulations as well. OMSZ with the choice of ALADIN/Climat and also with respect to the fact that the ARPEGE/Climat initial and lateral boundary data are available at the MetService will soon start the model integrations for the defined periods, i.e. 1961-1990 driven by ERA40 data, 1961-1990 (control), 2021-2050 (mid century) and 2071-2100 (end of century) driven by transient run of ARPEGE/Climat in scenario A1B.

DMI will continue supporting work on storage of the results, preparation and maintenance of the simulations and observations database for the project as well participation on comparison with previous results. Hardware will be acquired, and the necessary software will be installed. DMI will also investigate the effect of integration domain size. BOKU will work with RCM on improved surface scheme parameterization at high resolution comparing the results of subgrid effects parametrization. WUT will work on a new parameterization for boundary layer for high resolution RCMs and AUTH will continue exploring convective parameterizations in European RCM simulations with RegCM3.

2.3 WP3

2.3.1 Workpackage objectives

WP3 consists of four main objectives based on statistical procedures. Although 10 km resolution should be capable to bring many details in the results, there is still role for statistical techniques in addition to the basic comparison of 10 km dynamical downscaling with statistical one in postprocessing and contributing to interface between climate models (both global and regional) and climate change impact assessments in terms of other parameters not available directly from the models. Thus WP3 is supposed to utilize outputs from WP1 and WP2, namely gridded values of variables for both present and future climates; and making use of various statistical methodologies, it transposes them into meteorological data serving as inputs into climate impact models in WPs 5, 6, and 7. Some outputs of WP3 also enter WP4 where changes in extreme events are analyzed. Therefore, the main objectives of WP3 are:

- Construction of statistical downscaling models for the target areas / stations and variables
- Development and implementation of techniques of localization of RCM outputs into stations
- Validation of RCM and SDS outputs
- Construction of climate change scenarios for the target areas / stations and variables

In statistical downscaling, several frequently used methods will be employed. As target variables, temperature (maximum, minimum, mean) and precipitation will be used as well as some other variables will be downscaled based on impact sectors (WPs 5 to 7) claiming their necessity for the impact models. The target variables (predictands) will be defined in daily and monthly time steps. The participating institutions have a wide experience with these methods applied to various variables (e.g., Busuioc et al. 2001, 2005; Busuioc and von Storch 2003; Huth 2002, 2004, 2005; Mikšovský and Raidl 2005). A considerable step forward can be seen in carrying out a detailed comparison of several SDS methods, which has so far been rather scarce and limited to only a few selected validation criteria (e.g., extreme values in the STARDEX project, Goodess et al. 2005).

Two approaches to the localization of RCM output will be employed: One utilizes geostatistical methods and geographical information to derive the values at specified sites from RCM's gridded output (Benestad 2004); the other makes use of the MOS-like scheme, putting the RCM-simulated and observed data into a common framework (Widmann et al. 2003). Benestad's approach has already been utlilized e.g. for localization of outputs from two RCMs in Austria.

The RCM and SDS outputs will be validated according to several different validation criteria. These comprise the ordinary measures such as correspondence with observations (in terms of correlation and rmse), and the first two statistical moments (mean and standard deviation) where sensible (e.g., many SDS methods are designed so as to reproduce the mean and standard deviation, hence their validation is unnecessary; Huth et al. 2003). Other criteria to be used include: (i) measures of time structure of the series, such as lag-correlations (persistence); (ii) measures of spatial structure of the fields, such as spatial autocorrelations and divisions into homogeneous regions; (iii) recently observed trends and / or contrasting climatic states; (iv) characteristics of statistical distributions, such as higher-order moments; (v) relationships among downscaled variables and (in RCM outputs) between surface climate variables and driving synoptic fields. The added value consists mainly in a complex intercomparison of performance between the dynamical and statistical models, which has still been missing. It is important to note that the ability to simulate extreme values is also of great importance; the analysis of extreme events consists, however, a part of another WP (WP4).

Climate change scenarios will be constructed mainly for the target impact areas for two time slices (horizons) for which GCM and RCM data will be available: 2020-2050, and 2070-2100. For this purpose, several approaches will be used: (i) SDS models applied to outputs from GCM scenario runs, (ii) localized outputs from RCM scenario runs, (iii) stochastic weather generator modified by the GCM / RCM climate change response.

2.3.2 Progress towards objectives

The SDS and validation tasks are planned to be employed over a hierarchy of two different spatial scales. For a large scale, serving mainly for comparisons among SDS methods and of SDS methods with RCMs, a subset of a publicly available station network (e.g., ECA&D dataset; Klein Tank et al. 2002) over the region of interest (central and eastern Europe) will be used. Predictors in SDS models will be taken from the ERA-40 reanalysis (e.g., Uppala et al. 2004). In order to make intercomparisons possible, it is advicable to base all the SDS models and validations on a common, as long as possible, time period. In addition to this data, several smaller-scale dense nation-wide datasets are supposed to be utilized, with emphasis on the target areas for the impact assessments. Because of different regulations of the national meteorological offices, the access to these small-scale dense networks and their circulation among institutions in different countries is restricted. It is important to recognize that not all SDS methods are easy to transfer from one region to another and that some of them may not be suitable to training over large continental areas simultaneously, thus the sharing of the techniques is cumbersome. Thus, although all the tasks in WP3 need observed data for the development of the methods and their calibration and the original idea was to create a common broader dataset for the development and calibration of the methods, after discussions at the Bucharest and Semmerning meetings, it was decided that the common dataset as required for D3.1 will cover the area along the boundaries of the Czech Republic, Austria, Slovakia, and Hungary. The main intention was that the majority of the impact target areas in the central European region be covered by this dataset. Another leading thought in this decision was the idea that it would be easier to get the meteorological data from the meteorological services for only relatively small parts of the countries than for the large parts or even whole countries.

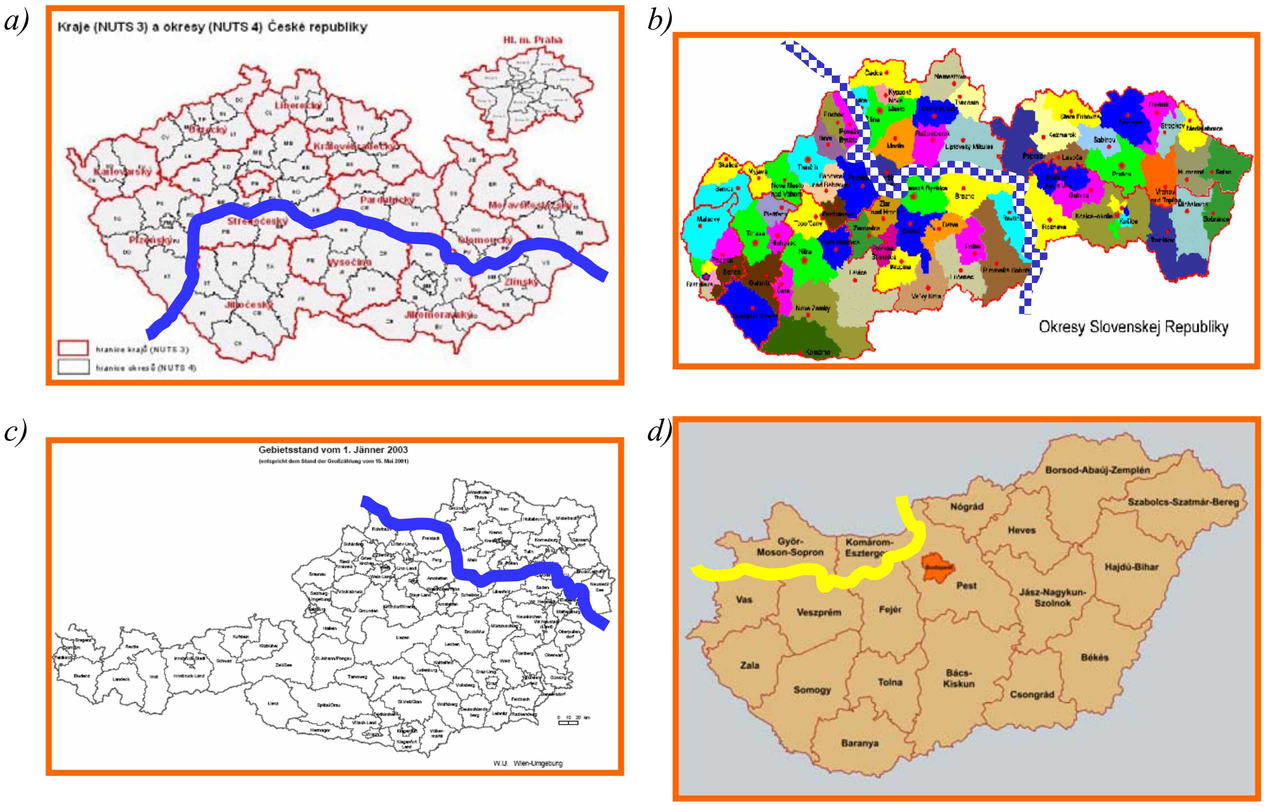


Figure 26: *Area covered by the common central European dataset – a) Czech Republic, b) Slovakia, c) Austria, d) Hungary*

Finally, the area covered in individual countries by the dataset can be seen in Fig. 26. It includes in the Czech Republic southern and south-eastern part, consisting of regions České Budějovice, Highlands (Vysočina), South Moravian, Zlín, and small southern parts of Central Bohemian; in Austria federal states Lower Austria, Upper Austria, Vienna and Burgenland; Slovakia contributes with data from western part, consisting of regions Bratislava, Trnava, Nitra, Trenčín, and Banská Bystrica; and from Hungary regions Györ-Moson-Sopron and Komárom-Esztergom are covered. The central European area covers the following impact target areas: for agriculture – Lower Austria (AT), southern Moravia (CZ), Danube lowlands (SK); for forestry – southern central Slovakia (SK); and for hydrology – Dyje and upper Vltava catchments (CZ), Hron catchment (SK). It was agreed that the dataset will be composed of daily data and that the following variables will be included there: maximum temperature, minimum temperature, relative humidity, solar radiation or, if not available, sunshine duration, as well as precipitation and potential evapotranspiration.

The following comments on the variables selected and not selected should be made:

1. Daily mean temperature was not included because of regional differences in its calculation and change in the practice in its calculation in Austria in early 1970's, which could induce an inhomogeneity in the time series and inconsistency along the state boundaries.
2. Relative humidity was selected, and not another measure of atmospheric moisture that is not affected by daily temperature cycle, such as specific humidity, because some of the impact models require just relative humidity as their input.
3. Wind speed and direction will not be subject to gridding and creating the technical series because of the necessity of working separately with the two wind components, which would cause considerable complications, making the resultant technical series doubtful and unreliable.
4. Potential evaporation is calculated from other variables (temperature, humidity) available as the technical series.
5. Solar radiation can be easily approximated from the sunshine duration data.

The dataset covers the period of 1961-2000. Even incomplete time series were allowed to enter the database. The data were prepared and provided by the following partners: CHMI for the Czech Republic, BOKU for Austria, FRI for Slovakia, and OMSZ for Hungary. To facilitate the procedure of getting data, an official letter signed by the project coordinator was sent to the director of the Hungarian Meteorological Service. The data policy of some of the involved meteorological services does not allow a distribution of raw station data. Therefore, we decided to create technical series from the station data available, which will further be distributed among the project participants. The technical series of two kinds are being constructed: (i) gridded datasets covering the area where station data are available; this will be a primary dataset; (ii) station technical series, which will have the advantage over the raw data in their better homogeneity and completeness. The technical series will be produced by CHMI. Before processing, the station series will be quality controlled anyway and, if necessary, homogenized where needed (using AnClim and ProClimDB software of Petr Stepanek, CHMI, more details can be found at www.climahom.eu, the software is ready and available for the rest of the community, see Figs. 27 and 28) and feasible (mainly in cases of combination of near stations measurements).

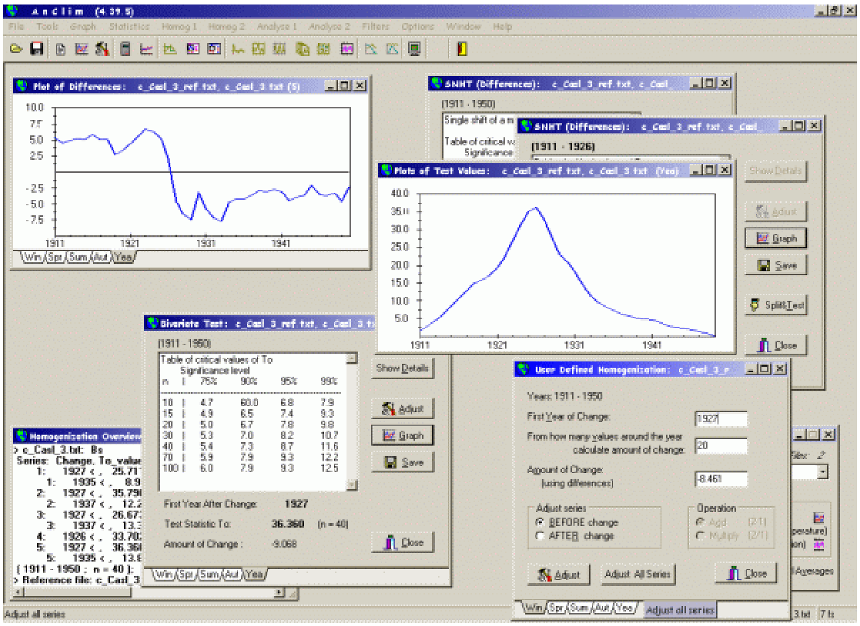


Figure 27: *Homogenization Tools in the AnClim software – an example.*

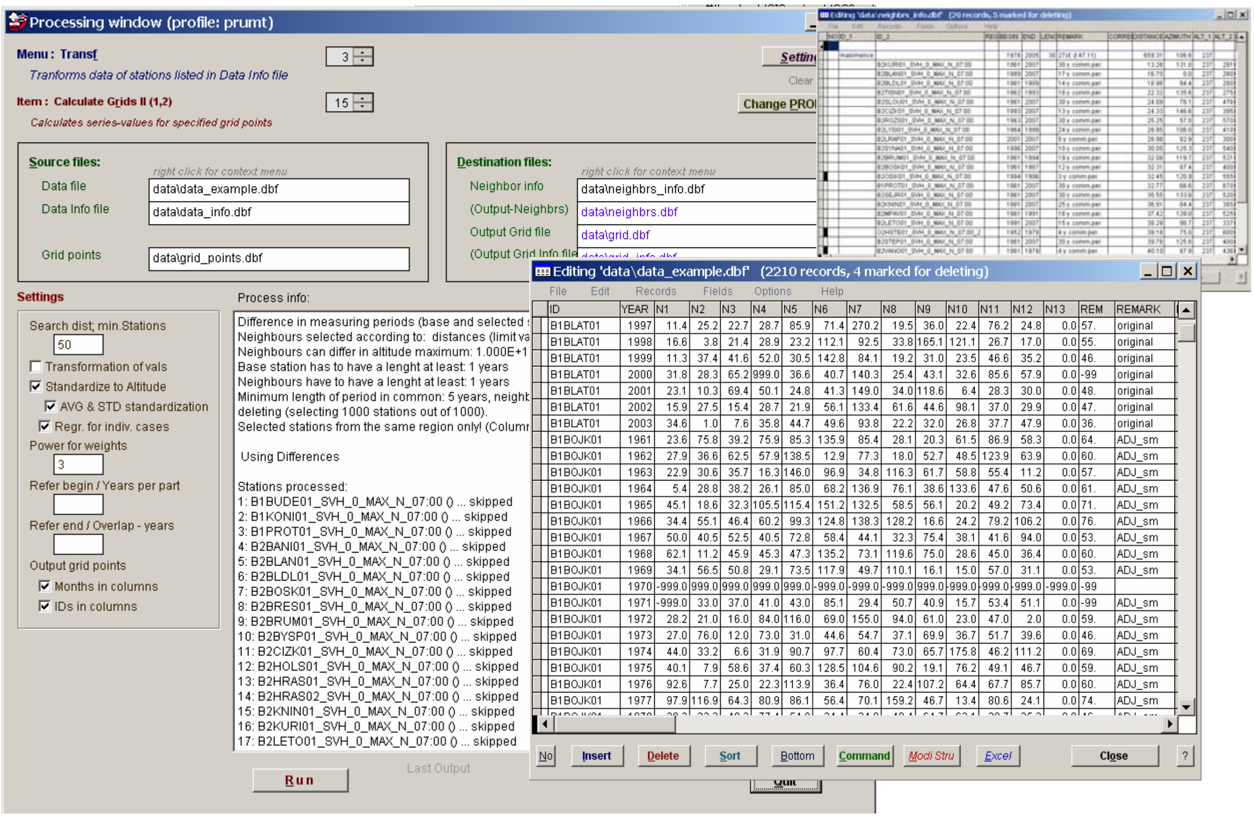


Figure 28: *Example of ProClimDB software appearance*

Several methods can be applied for calculating values of a given meteorological element at a certain geographical position. Weighted mean is among the simple ones and most commonly used in the past, the weights can be applied like inverse distances or correlations, possibly powered, to control lower or higher spatial variability of a given meteorological element. The better option is, without doubt, to use geostatistical methods. Applying geostatistical methods on time series is not an easy task (mainly due the computational demands), but some attempts that combine time and spatial analysis already exist and such methods have started to be used more widely in recent time. Methods such as kriging, co-kriging (i.e. using information of other climatological elements or geographical variables such as altitude, longitude, latitude) and universal kriging will be employed for this purpose. The technical series and gridded data will be calculated by means of the geostatistical methods applied to time series using combination of the R software (GNU project, www.r-project.org) and the software ProClimDB of Petr Stepanek (www.climahom.eu) accomodated for purposes of the project Cecilia by adjusting and adding new functions. CHMI within the first year of the project Cecilia concentrated on establishing tools for ProClimDB and R software collaboration where needed (e.g. methods based on maximum likelihood). The central European dataset will be made available to all partners working on any task especially in WP3, WP5, and WP6 in the area in question.

In the Eastern Europe for Romania the dataset will consist of the stations in the south-eastern part of the country – see Fig. 29. They will be used for work mainly in WP3 and 5 by the Romanian partners. Only a limited number of stations, which are being submitted to the international networks, can be made available to other partners. Behind the border there, in north-eastern Bulgaria the dataset was prepared for agricultural impacts by NIMH. The dataset consists of monthly mean minimum and maximum temperature and precipitation over 1961-2000 at 6 stations. Data can be made available for other CECILIA partners.

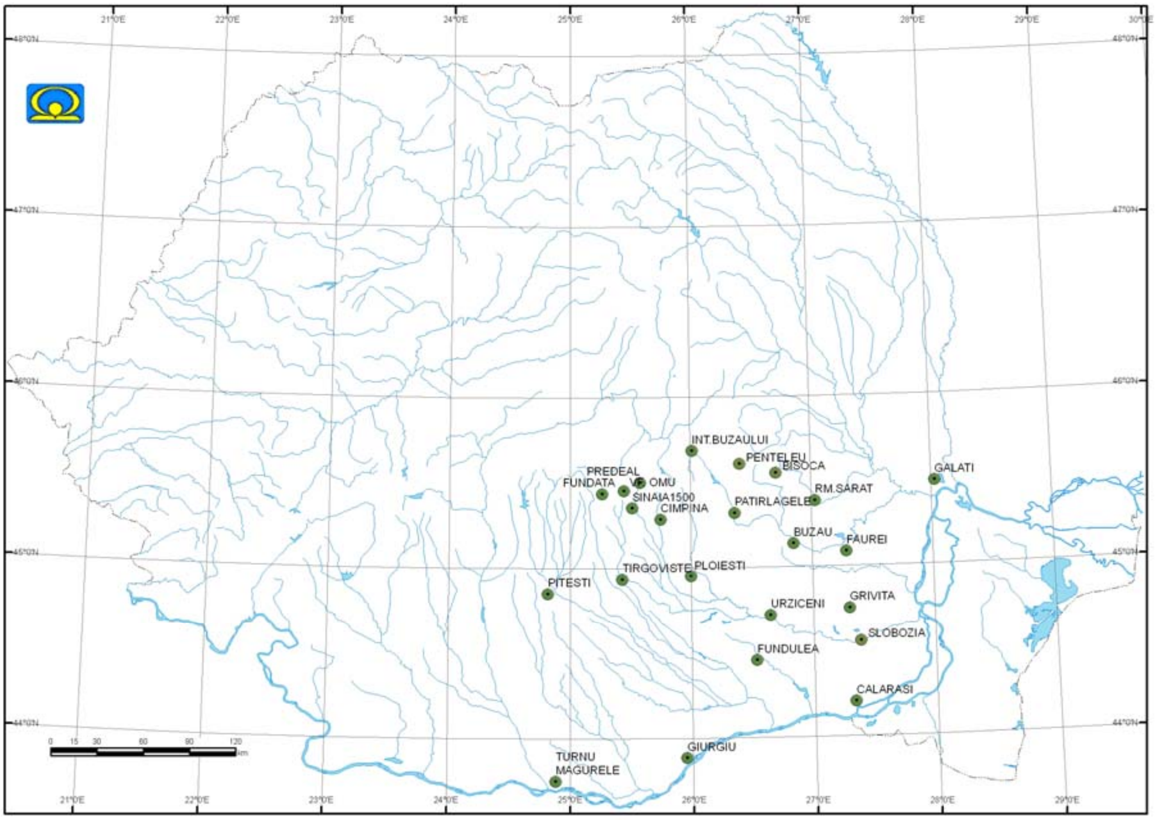


***Figure 29:** Location of stations in the Romanian dataset.*

For basic application of statistical downscaling it was decided that the predictors will be taken from the ERA-40 reanalyzed dataset. It was also decided that no unified procedure of extracting the data will be prepared and that each partner will access to the data, recode them and convert individually. The original idea of conducting the statistical downscaling exercise within the CECILIA project was that individual methods will be trained and validated on a common dataset. However, it appeared during the first months of the project that some methods are difficult to transfer from one region to another, i.e. since they require time consuming calibrations. To elucidate which partner will carry out which downscaling method, for which variables and for what region, a matrix was produced (see Tab. 3). It is necessary to emphasize that each variable is covered by at least one method and that comparisons of a relatively large numbers of methods will be made possible for some variables (e.g. minimum and maximum temperature), which have potential to be of high scientific value. The individual partners carried out the necessary work in the implementation of SDS methods and their preparation for their use in the coming steps of the project.

Table 3: *Statistical downscaling methods – distribution among institutions and variables. D = daily, M = monthly values.*

partner	method	variable								
		T	TX	TN	PR	rad / sun	RH	W sp	W dir	evap
IAP	multiple regression, CCA	D	D	D		D	D	D		
	neural nets	D	D	D		D				
	"model scaling"							D	D	
CUNI	multiple linear regression	D	D	D	D		D			
	local models (constant & linear)	D	D	D	D		D			
	ANNs (multilayer perceptrons & RBF nets)	D	D	D	D		D			
NMA	CCA	M	M	M	D		M	M		M
	conditional weather generator				D					
ELU	downscaling using MCP types defined by cluster analysis	D			D					

At IAP it was mainly programming and calculating classifications for the classification-based methods; the clasifications used are based on the 1000 and 500 hPa heights using the k-means non-hierarchical clustering method and principal component analysis in T-mode. Furthermore, pilot study was performed on the feasibility of statistical downscaling of wind speed and direction. This study was carried out for a limited number of stations and it was found that (i) wind speed can be determined both directly from the upper-air data and from wind components downscaled from the upper-air data with a reasonable skill; (ii) the latter approach is more skilful; (iii) methods of debiasing or rescaling upper-air real or geostrophic wind at 850 hPa are less successful; (iv) wind direction is more difficult to downscale, its skill being relatively low; and (v) the only reasonably skilful method of downscaling wind direction is downscaling of west and south wind components, from which the wind direction is recalculated. Moreover, the linear and neural-network (multilayer perceptron) based SDS methods were implemented for their application to daily temperature.

At CUNI individual downscaling methods have been implemented (Milestone M3.2, Month 12) and prepared for later application in the frame of deliverable D3.3. These include one linear (multiple linear regression) and several nonlinear techniques (locally linear and locally constant models, multilayer perceptron artificial neural networks and radial basis function artificial neural networks). Along with preparation of individual methods, suitable sets of predictors (their number and type) have been found, as well as values of needed parameters and other settings, such as optimal topology of neural networks and size of local neighborhood for local models. So far, the downscaling models have been tested for daily mean, minimum and maximum temperature and daily precipitation series from several Czech stations and for selected records obtained from the ECA&D database (http://eca.knmi.nl/). Root mean square error and correlation measures have been applied for validation of the results, along with several descriptors of statistical distribution of the processed variables (e.g. precipitation quantiles). Training of downscaling mappings was done using NCEP/NCAR reanalysis data, climate model HadCM3 was used as a representative of GCMs (in the consequent work, CECILIA runs of regional models RegCM and ALADIN driven by the global models will be utilized instead). Final testing, evaluation and ranking of the downscaling methods will be done (in cooperation with other WP3 participants) upon completion of the common dataset of observed data, prepared for deliverable D3.1 (Month 12). Also, other variables will be downscaled in addition to temperatures and precipitation - relative humidity and possibly wind speed and wind direction.

Preliminary work has been done at NMA on improvement of the statistical downscaling method based on CCA, developed for monthly maximum and minimum temperature, by considering the temperature at 850 hPa as predictor. Before, these models have been developed for seasonal values. Since for some impact models information on monthly scale is necessary, during the reported period, these models have been developed for maximum temperature monthly mean by considering the monthly anomalies for the cold (November-April) and warm period (May-October) together, respectively. In this way the data size has been multiplied by 6, allowing to use longer periods for validation/calibration and to obtain more robust models. The model has been tested for 26 stations covering the entire Romanian territory. The data set covers the period 1961-2000, which has been divided into two sub-intervals 1961-1980 and 1981-2000, used as calibration and validation intervals, respectively. Then the situation has been reversed. These preliminary results show that the model is stable and skilful over both sub-intervals considered as independent data set: a little higher skill has been identified for the warm season (explained variance between 55% and 87% for independent data set, compared with 52%-80% for the cold season). These results are presented in Fig. 30. It is known that the model skill is strongly dependent on the number of EOFs used in CCA and number of CCAs used in SDM calibration. This combination is stable in time for the cold season.

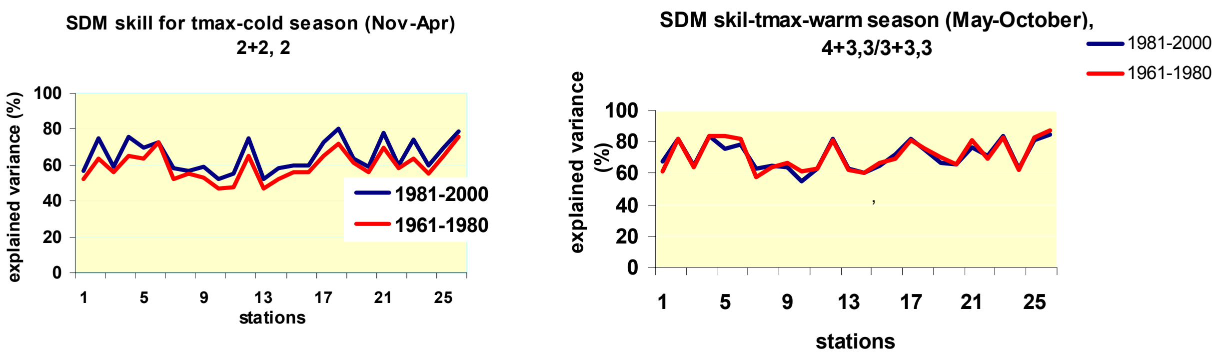


Figure 30: *SDM skill (expressed as explained variance of the reconstructed values from the total observed variance) for monthly maximum temperature at 26 Romanian stations for the cold season (top) and warm season (bottom). The values refer to the two independent data set: 1961-1980 (red) and 1981-200 (blue).*

The stochastic downscaling method of ELU is based on the fact that there exists considerable stochastic relationship between the large-scale atmospheric circulation and the meteorological variables (e.g., temperature and precipitation). This relationship is estimated from observed data and then it is used with large-scale circulation available from GCM or RCM outputs. Thus, an estimation can be obtained for local meteorological parameters under new climate conditions. Large-scale circulation is characterized by macrocirculation (MCP) types, which are defined using cluster analysis to the corresponding meteorological variables (temperature or precipitation). The cluster analysis will be accomplished on a seasonal basis. The stochastic downscaling method was tested for two vulnerable regions in Hungary (Great Plain, watershed of Sio-Lake Balaton).

For statistical downscaling and model runs validation (D3.3) the list of criteria according to which the dynamical and statistical downscaling methods will be evaluated was produced. We attempted to sum up criteria that would in particular be useful for the impact researchers; for that purpose, we requested the impact researches to suggest criteria specific for their own impact sectors, models, species, etc. We expected suggestions of especially various threshold criteria; however, the response from the impact community was not numerous, the only partner having expressed their needs in validations for their agricultural and hydrological models was IAP. The validation criteria to be applied within the CECILIA project to both RCM and SDM outputs include (i) mean and standard deviation (which is irrelevant for some SDS methods because they are able to reproduce the mean and standard deviation by definition); (ii) measures of correspondence with observations, such as correlations, root-mean-square error, mean absolute error, etc.; (iii) annual cycle; (iv) characteristics of statistical distributions, including higher-order moments; (v) temporal structure, including temporal autocorrelations, and characteristics of day-to-day variations; (vi) spatial structure, including spatial autocorrelations and spatial clustering; (vii) trends and the ability to reproduce past contrast climate states; (viii) relationships among variables, including those between predictors and predictands in SDS, and including evapotranspiration as a combination of several other variables; and (ix) impact-oriented threshold-based criteria.

The examples of impact-oriented validation criteria important in crop growth modelling include mean daily temperatures below –10 C and minimum temperatures below –18 C which are likely to damage the wintering crops, minimum temperatures below –2 C in May and June likely to damage crops during their growth, and days with minimum temperature below –1 C during June to September.

To determine and decide, which partner will carry out which validation task, a matrix was produced (Tab. 4). The attribution of the validation task to individual partners is also displayed there. It is important to note that some partners will not carry out validation of all model outputs but only of some of them, especially those produced by their own institutions. This applies, to different extent, to NMA, NIMH, OMSZ, and ELU. At CUNI, using the outputs of an ongoing run of ERA-40-driven RegCM model in 10 km resolution, preliminary validation has been performed for selected characteristics of temperature and precipitation. Model outputs were compared with series measured at a few Czech weather stations, for the period 1961-1966. This analysis will be further continued as longer runs and simulations driven by ERA-40 and control by GCM become available from WP2, and it will be synchronized with validation tasks planned for deliverable D4.4.

For the output localization (D3.2) the preliminary work consisted mainly in the discussions on procedures to be used and principles to be followed during the work. At the meeting of the participants involved in D3.2 during the Chalkidiki meeting, the following principles were agreed upon: (i) one small region for the application of the output localization methods will be selected; it will be either north-eastern Austria or south Moravia; (ii) all the available methods will be applied there; (iii) the best method will be selected if possible; and (iv) the selected method will be applied in other small training areas and finally to the RCM outputs. At BOKU it is planned to use an output localization method for temperature minimum and maximum based on a monthly regression model. As predictor field the relative topography 850-700 hPa of the grid boxes directly over the station with bias correction based on the differences per percentile between RCM-Control and ERA-40 are used. The method was already tested at selected stations in Austria for temperature maximum in summer. At CUNI along with statistical downscaling methods, techniques for localization of RCM outputs are being developed for deliverable D3.2 based on interpolation techniques, using local application of multilayer perceptron neural network. This work is currently in progress; performance of the methods will be tested in the next period, initially with ERA-40 data, then for RCM simulations in 50, 25 and 10 km resolution.

Table 4: *Distribution of validation tasks among partners.*

validation criterion	IAP	CUNI	CHMI	NMA	NIMH	BOKU	ELU	OMSZ
mean, standard deviation	X	X	X	X	X		X	X
correspondence with observation (rmse, mae, corr, …)	X	X	X	X	X		X	X
annual cycle		X						
statistical distributions, incl. higher order moments	X		X					
temporal structure (autocorrelations, distrib. of day-to-day changes, …)	X	X					X	
spatial structure (autocorrelations, clustering, …)	X			X			X	
trends	X		X	X				X
relationships among variables, evapotranspiration				X		X		
impact-oriented threshold / extreme characteristics	X		X		X			

2.3.3 Deviations from the project workprogramme

As mentioned in previous paragraphs, there were certain problems due to data policy of some meteorological services which does not allow their data to be freely used by other partners. Therefore, to make an exchange of data and creation of a common dataset possible, it was decided to limit the effort just for smaller significant regions and to produce technical series, which can be distributed among partners without obstacles – see above. The construction of technical series represents a major task and requires considerable efforts and time, it was, however, not foreseen in the DoW. As a consequence, it happened that one of the tasks within the D3.1 deliverable (Preparation of datasets) could not be completed by month 12. The time needed for completing the deliverable should be extended by four months, until month 16. This extension will not affect any other work in any other deliverable of any WP. Similarly, a part of M3.1 (datasets prepared) was not achieved, that time solution of the problem with data was discussed and finally decided at Semmering meeting. All other progress on the work on the project corresponds to workplan and it will not be affected by the delay in datasets available by month 16.

2.4 WP 4

2.4.1 Workpackage objectives

The main tasks following DoW of WP4 are as follows:

- Analyses from observational datasets of various measures of extreme weather events and related processes for present-day climate in Central and Eastern Europe, using both regional as well as local datasets in participating countries as covered by the WP2 10 km simulation.
- Determination of suitable percentiles of precipitation and temperature, as well as extremes indices (based on WMO, STARDEX) for the validation of the present-day experiments and assessment of climate-change simulations.
- Validation of present-day climate simulations with regard to extremes based on global and regional climate simulations at scales of 50 km down to 10 km. Assessment of the added value of 10 km simulations in focus regions (Czech Republic, Carpathian basin, Romania, and Bulgaria).
- Estimates of the effects of climate change on extreme weather events based on pre-existing GCM and RCM output as well as 10 km WP2 simulations; in particular analyses of changes in droughts and heatwaves, as well as in heavy-precipitation intensity distributions, with detailed analyses in focus regions.
- Process analysis of important feedbacks using sensitivity experiments; assessment of impact of model resolution and domain size on the analyzed processes.

The main objective of workpackage WP4 was planned to deal with the analysis of the impact of climate change on the occurrence of extreme weather events in Central and Eastern Europe. In the first stage of the project, WP4 was expected to focus on the analysis of extreme events in Central and Eastern Europe from observations, with the possible identification of existing trends in the recent period. Beside regional datasets (e.g. European Climate Assessment & Dataset, ECA&D), WP4 will also take advantage of the analysis of local datasets available to the individual WP4 partners (CHMI, ELU, NMA). The suitability of other datasets available from local sources will be assessed in collaboration with all WP4 and WP3 partners, together with the selection of the sets of extreme indices following WMO and STARDEX proposals relevant for the analysis in D4.1, D4.2. A second focus of WP4 was defined to be the assessment of the added value of 10km resolution for the simulation of extremes. Particular consideration will be given to intensity distributions, extremes indices, as well as relevant feedback processes. Finally, WP4 will assess future trends in extreme weather events for Central and Eastern Europe, based on pre-existing GCM and RCM output as well as the 10 km WP2 simulations. This will encompass analyses of changes in droughts, heatwaves, and heavy-precipitation intensity distributions, as well as the computation of changes in related extreme weather indices as selected in D4.1. Process analyses of important feedbacks (*e.g.,* land-atmosphere coupling) will be performed with sensitivity experiments. The impact of model resolution and domain size on the analyzed processes will be investigated, as well as the relation between the driving GCM or RCM fields and the downscaled simulations. (D4.3, D4.4, D4.5, D4.6)

2.4.2 Progress towards objectives

In the first stage of the project, WP4 started with the preparation of the analysis of extreme events in Central and Eastern Europe from observations, with the possible identification of existing trends in the recent period. Beside regional datasets (e.g. European Climate Assessment & Dataset, ECA&D), individual partners of WP4 (CHMI, ELU, NMA) used their own local datasets available making first tests of the methods for the analysis. The suitability of these datasets was assessed in collaboration with all WP4 partners and the selection of the sets of extreme indices following WMO and STARDEX proposals relevant for the analysis were concluded for D4.1 and D4.2. The participants to this WP are ETH (lead partner), DMI (co-lead partner), CUNI, NMA, CHMI, ELU, IAP, OMSZ, ICTP, AUTH, and NIMH. Studies for the whole region are coordinated by ETH for droughts and heat-waves and by DMI for heavy precipitation; country-based studies will be performed at local institutions in collaboration with ETH and DMI.

Achieving the Milestone M4.1, on the basis of indices of extremes defined by the WMO and the STARDEX project, 131 indices to be validated have been chosen by the WP4 partners for deliverable D4.1 (submitted on Month 6). These indices will be computed on various time frames (i.e., annual, seasonal (MAM, JJA, SON, DJF) and monthly time frames) and as climatological estimates over the following time periods: 1961-1990, 1961-1970, 1966-1975, 1971-1980, 1976-1985, 1981-1990, 1986-1995, 1991-2000, and 1996-2005. Moreover, 41 of the indices have been defined as "core indices" and will be available as time series of annual values as well.

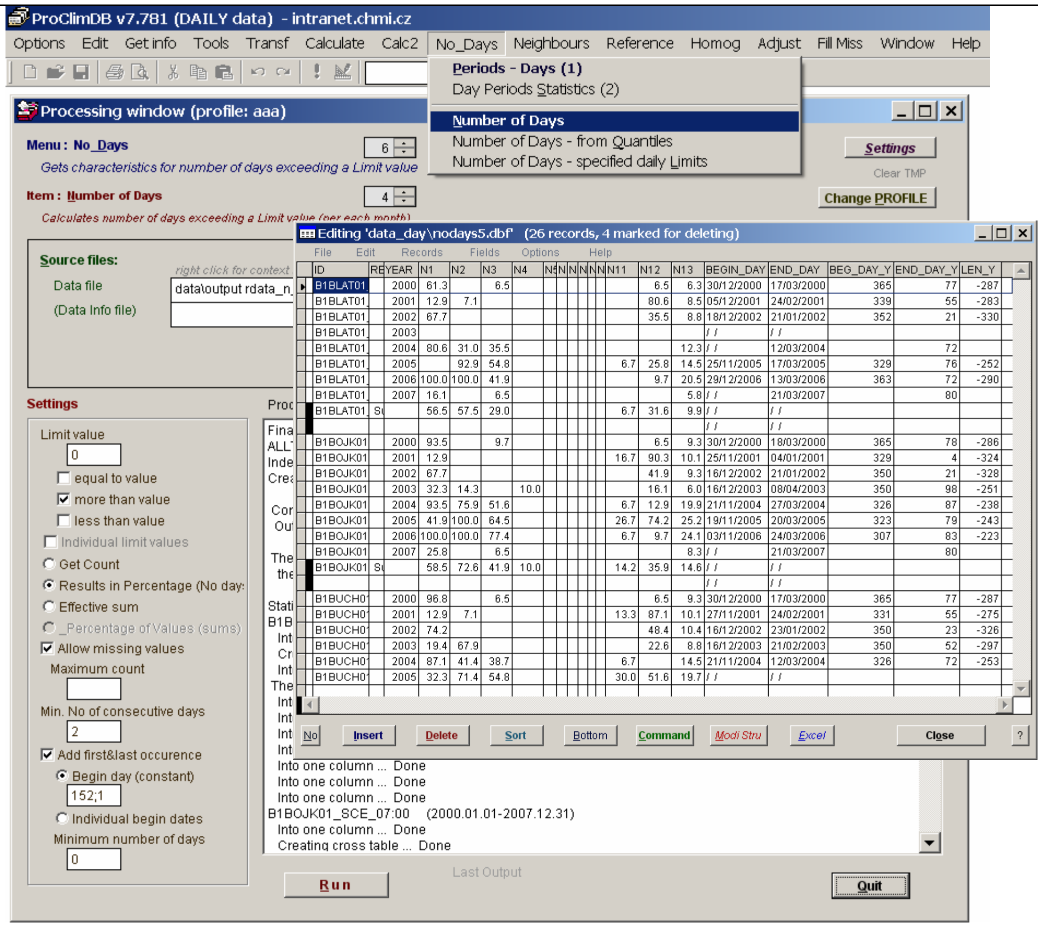


Figure 31: Example of the ProClimDB software appearance

The observational data sets to be used for the validation of the indices have been specified. These datasets include the ECA&D dataset, as well as data from the local partners (i.e., CHMI, OMSZ, ELU, NMA, NIMH). The indices will be computed from daily data as part of D4.2. The software ProClimDB (http://www.climahom.eu/ProcData.html) has been finalized at CHMI for the needs of WP4 by adding additional functionality, and can be used for the consistent calculation of the indices by the WP4 partners (see Fig. 31). For this purpose, a description of the procedures for indices calculation has been prepared by CHMI. At the workshop in Kalithea, Greece, a due date for the calculation of the indices from the observational datasets of the local partners and from pre-existing model runs has been set and the storage of the indices at DMI has been discussed.

For D4.2, preparation for analysis of existing or ongoing daily model outputs (GCM, 50km, 20km as well as one set in 12km resolution) available through the data servers of the EU projects PRUDENCE and ENSEMBLES or from DMI has been started. This first data stream will be used for initial analyses of realism, resolution effects and impact of model/scenario choice on the simulations. Particular consideration will be given to intensity distributions, extremes indices, as well as relevant feedback processes. Once available, the RegCM3 and Arpège European simulations delivering boundary conditions to the 10km CECILIA RCMs will be analyzed, and finally the 10km simulations themselves will be investigated, with a special focus on the Czech republic, the Carpathian basin, Romania, and Bulgaria. (D4.2, D4.3, D4.4)

2.4.3 Deviations from workprogramme

All the requirements of milestone M4.1 were achieved in time and the deliverable D4.1 was delivered in due time as well. No deviations from the plan expected.

2.5 WP 5

2.5.1 Workpackage objectives

The main objectives of the WP5 has been defined in DoW to be:

- Analysis based on high resolution CECILAI RCM outputs of the climate change impact on hydrological resources in the central and eastern Europe,
- Analysis of the climate change impact on the flood events,
- Assessment of the managed water resources, demand and vulnerability and corresponding adaptation measures for present and projected climates,
- Assessment of impacts of the climate change on water quality: changes of nutrient (N, P) concentrations and eutrophication in a reference river network with reservoirs used for drinking water supply and recreation, and
- Study of the impacts of global change signal on local climate variability of air-sea coupled modes for the western Black Sea coast.

In view to estimate the impact of the climate change on the hydrological resources and other consequences for water quality and management in WP5, mathematical models of rainfall-runoff and water quality in the river network and reservoirs were supposed to be used for the reference (pilot) basins. Moreover these basins were selected for the assessment of the vulnerability of water resources and corresponding adaptation measures. To estimate the climate change impacts, these mathematical models were planned to be applied in the cases of present regime (actual climate, control runs) and modified regimes (scenario runs). The climatic scenarios will be considered the most suitable for the climate and orographic conditions of Romania and the Czech Republic.

For these experiments the models have to be calibrated for appropriate locations and adapted for high resolution inputs from RCM runs. The tasks of WP 5 during the reporting period consist in description of the rainfall-runoff models and of the reference basins, analysis of natural conditions, climate, hydrology, development of land use, surface water quality, and water management during the period from the 1960s to the present, calibration of the rainfall-runoff models over the selected period (1970-2000). In order to assess the impact of the climate changes upon the water resources, four reference river basins were chosen: Ialomita–Buzau area (19 040 km2) from Romania, Dyje river basin (17,800 km2), which are the tributaries of the Danube river, and Vltava basin (11 500 km2) from Czech Republic, and Hron river basin (5 465 km2). For rainfall-runoff models calibration, each partner participating in WP5 has done the simulations of the monthly river flows in present climate. The input meteorological data (precipitation, temperature, relative humidity, sun radiation and mean speed of wind) were considered as averaged values over the canalised river basins area.

Another objective of WP5 is to find out the hydrologic impact with the view of hydrologic extremes – mainly flood events. For this purpose HIDROG model was supposed to be recalibrated according to flood events of last years (especially large floods in August 2002 and snow-melting in March 2005). Special attention is given to water quality and eutrophication of reservoirs. A modelling system is developed to simulate precipitation-runoff processes and water quality. The impact of climate change on hydrological-related resources of the unique environment system represented by the Black Sea coast was focused on local phenomena identified to have a major impact on regional sustainable development.

2.5.2 Progress towards objectives

For the Deliverable D5.1. description of the rainfall-runoff models and of the reference basins, as well as a revision of flood events from the analyzed period, preparation of the input data and the schematization of the reference basins was prepared. The river basins selected for the determination of the impact of possible climatic changes on hydrology, water quality and management of surface water resources are Buzau (8944 km2) and Ialomita (19 040 km2) from Romania, Hron catchment to Brehy (subcatchment of an area of 3 821 km^2) from Slovakia, Dyje (17,800 km2) and upper Vltava River (17,780 km2) from Czech Republic.

The area of Buzau and Ialomita river basins is located of the outside of Curvature of the Carpathian Mountains, into a zone where the altitude varies from 2500 m to 50 m. In conformity of altitude, the annual precipitation varied from 1400 mm/year, in the mountainous area to 400 mm/year in the plane area and the evapotranspiration between 500 mm/year in the high area to 850 mm/year in the plane area. However, due to a very high variability of weather conditions, droughts as well as excessive humidity periods occur in the course of a year. For assessing the impact of the climate changes upon the water resources in Buzau and Ialomita river basins, the WATBAL model is used. This is a water balance model with monthly time step and it is combined with the Priesley-Taylor method for calculating the potential evapotranspiration. The study area was divided in 17 sub-basins and WATBAL model will be apply in each sub-basin. The model input data are precipitation, air temperature, relative air humidity, wind speed, sunshine duration and runoff, data of 7 meteorological stations and 50 runoff gauging-stations will be used.

The Dyje catchment is located in the south-eastern part of the Czech Republic. The catchment area of the river Dyje as far as the gauge station Ladná is 12.280 km^2 and the long-term average discharge (Qa) is 41.7 m^3/s. The elevation above sea-level of water gauge's zero of the station Ladná is 157.38 m a.s.l. and so it represents the lowest point of the reference basin. The highest point of the Dyje basin is the hill Javořice (837 m a.s.l.) situated about 13 km west from the municipality Třešť. Concerning the landuse of the Dyje catchment the fields and forests are the prevailing form. For simulation of changes in future runoff and other water balance components in this river basin due to the climate change, the BILAN water balance model will be used with monthly time step. This model is structured as a system of relationships between river basin components on the land surface, in the soil zone of aeration, including the effect of vegetation cover, and in the groundwater aquifer. Air temperature is used as an indicator of energy conditions, which affect significantly equilibrium between the water balance components. The entry data of the model are monthly series of basin precipitation, air temperature and relative air humidity. To calibrate the parameters of the model observed monthly runoff series at the outlet from the basin are used. For assessment of basin air temperature and relative air humidity there will be used measured data series of air temperature and relative humidity from 12 climate stations and for assessment of basin precipitation there will be used measured data series of precipitation from these 12 climate stations too and from next 13 precipitation stations. All these stations are situated on the Czech part of Dyje river basin.

For simulation of potential future flood events (hydrological extremes) the model HYDROG will be used. This is a distributive event rainfall-runoff model. A schematization of a catchment is performed by subdividing it into sub-catchments with constant properties (slope, roughness, hydraulic conductivity in a saturated environment) and the rainfall-runoff process can be solved in a simplified way, i.e. as a one-dimensional problem. When simulating the flow of water through a subdivided catchment (spatial-surface runoff and concentrated runoff), the Saint-Venant Equations (continuity equation and an equation based on the law of motion preservation) simplified by a kinematic wave approximation are used for the description of the dynamic performance of the system. For the computation of the dynamic change of groundwater runoff a conceptual regression model, which uses only groundwater storage, is used. Of the hydrological losses, an important one is the infiltration loss - for its calculation the model uses the modified Horton method, which estimates the amount of initial infiltration from the rainfall sum that occurred in the proceeding period (week). Other losses are included in the initial threshold value, when the aerial surface runoff is triggered off only after this value is exceeded.

The upper Vltava River basin with a closing profile at Vrane n/V is situated in the southern part of the Elbe River basin. The altitude of the river basin ranges from 170 to 1380 m. The annual mean temperature is about 9°C at the lowest parts of the basin and <5°C at altitude above 1,000 m. At the mean precipitation amount of 680 mm the evaporation in the basin is 508 mm (72% of precipitation). More that 60% of the annual runoff volume from the basin occurs during the winter hydrologic period (November-April). Water quality data include oxygen conditions (dissolved O2), 3 deteminations of organic substances (biochemical oxygen demand - BOD5 - and chemical oxygen demand by permangate - CODMn - and dichromate - CODCr - methods), suspended solids (TSS) and their loss on ignition (LOI), nitrate nitrogen (NO3-N), ammonia nitrogen (NH4-N), phosphate and total phosporus (PO4-P and TP, respectively), chlorophyll-a etc. The Vltava River experienced a period of heavy organic pollution from a paper mill situated at Vetrni (cca 30 km downstream from Lipno Reservoir) until 1990. The pollution with nitrate and phosphorus peaked during the early 1990s.

The HSPF model will be used for the assessment of the impact of the climate changes upon the water resources in the upper Vltava River basin. This model is a conceptual precipitation-runoff model with a modular structure that enables simulations of transport of multiple substances from the catchment and their transformations in the river network. Simulations are accomplished in user-defined separate parts of the catchment and of the river network that have similar soil, water ecosystem, and climate conditions. The upper Vltava River basin was divided into 69 sub-catchments. Each sub-catchment is composed of 5 segments that represent farmland, low-slope (<8°) areas, high-slope (>8°) areas, flood areas (maximum distance of 100 m from the channel and with slope <1°), and impervious areas. The model outputs in a format of text files are used as input files for the subsequent simulations with the reservoir model CE-QUAL-W2. In this model the reservoirs are approximated with a finite-difference grid that typically consists of segments 300 m to 1 km in length and 0.5 m to 1 m thick. Water quality simulations include the following quantities: temperature, water age, dissolved oxygen, biomass of 3 phytoplankton groups (ALG1, ALG2, ALG3), labile and refractory dissolved and particulate organic matter (LDOM, RDOM, LPOM, RPOM), orthophosphate P (PO4-P), NO3-N, and NH4-N.

For the Deliverable D5.2 dealing with calibration of the monthly river flows over the selected period (1970- 2000) and the rainfall-runoff models according to the flood events over the same period the experiments were performed by WP5 partners (CHMI, IAP, FRI and NIHWM), concerning the parameters calibration of the models which will be used by each partners for the assessment of climate change impacts on hydrology and water management in different river basins.

As the application of BILAN water balance model is suitable for catchment areas from 100 km2 to approximately 1000 km2, for calibration of the model for Dyje river basin (Czech Republic) 9 sub-basins will be used for the analysis of monthly runoff series over the selected period 1970-2000. Measured data series from 16 climate stations have been utilized for assessment of basin air temperature and relative air humidity, for assessment of basin precipitation in addition to this data measurements from 13 precipitation stations were used. Only two catchments has been calibrated so far, namely Jevišovka basin and Rokytná basin. The comparison of measured and simulated mean monthly discharges is presented for Jevišovka basin in Fig. 32. In addition, the monthly averages of observed and simulated runoff during the long-term period were compared. It can be seen in Table 5.1 that the departures between the observed and simulated long-term averages are significantly higher than 20% only for a few months (December, January, October), so that the results can be considered to be acceptable. For Rokotná the results are slightly worse.

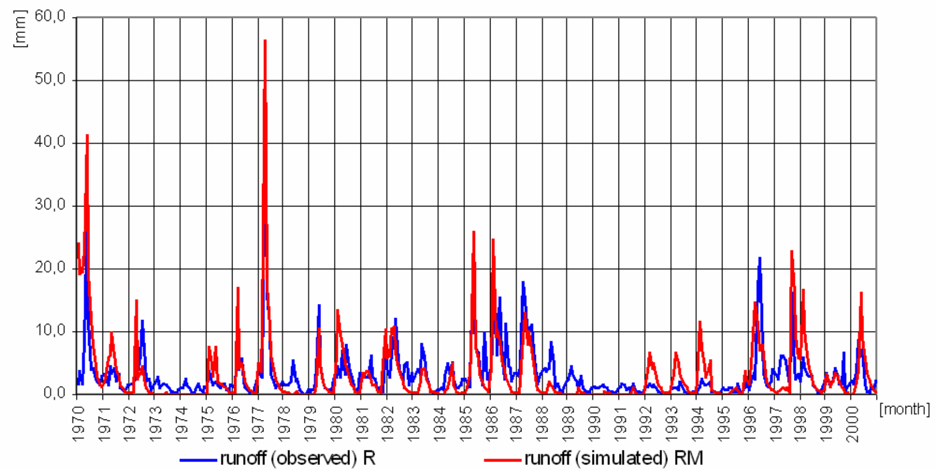


Figure 32: *Comparison of observed and simulated monthly runoff at the Božice hydrometric station,*

Table 5: *Comparison of monthly averages of observed and simulated runoff at the station Božice during the calibrated period 1970-2000*

	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X
R [mm]	2,1	2,7	2,9	5,4	7,0	4,7	3,0	2,3	2,0	1,4	0,9	2,1
RM [mm]	2,2	4,0	4,6	6,5	6,7	4,0	3,1	1,8	1,8	1,1	0,9	0,8
100.(RM-R)/R [%]	4,8	48,1	58,6	20,4	-4,3	-14,9	3,3	-21,7	-10,0	-21,4	0,0	-61,9

As for the simulation of flood events in Dyje river basin (Czech Republic), it should be mentioned that in the Czech Republic the most of the floods are caused by precipitation and snow melting occurring just in the territory of this country. The hydrological model simulation of passage of floods which happened before 2000 is very complicated because of absence of sufficient details in time and spatial input data. The main problem is availability of the input data for the model. If we want to focus on the extremes, we need the data of a very high time and spatial accuracy.

Since the operative hydrological modelling in the Czech Republic started in 1996, the strong demands on higher concentration of a raingauge networks was given after 2000. The great improvement brought the year 2002, when the computation of the quantitative precipitation estimate (QPE) based on radar measurement combined with information from raingauges started calculated every hour. These estimates are based on radar measurement combined with raingauge measurement and they are used as a standard input for the operative hydrological modelling. The model catchments were divided into smaller rainfall areas (about 90 km2 – see Fig. 33) which enables to describe the rainfall process better, i.e. more accurate input rainfall data are available for the model.

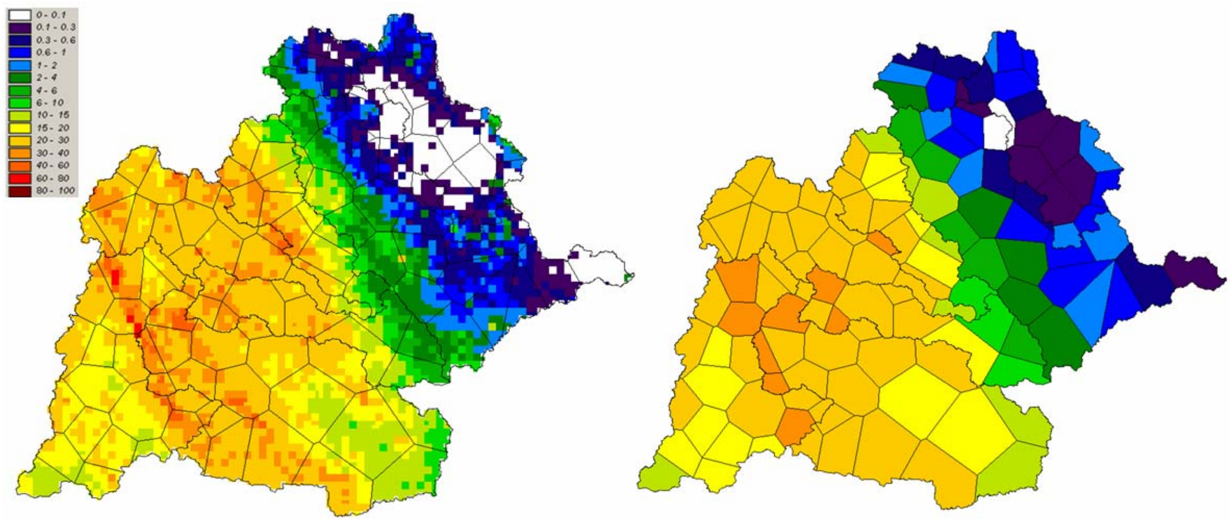


Figure 33: *Precipitation: Left – the radar QPE (in mm), right – model input.*

For the simulation of floods the continuous database of QPE for model rainfall areas was created. This database stores the data since 2002 and performs the very good estimation of the real precipitation – a proper input for HYDROG model. As example the simulations at profiles Janov (no. 57) and Podhradí (no. 170) for the flood in August 2002 are given in Fig. 34. The correspondence of the simulated and real discharges is good – much better than simulation of historical floods.

The simulation of extreme floods which occurred in August 2002, March-April 2006 and July 2006 based on reliable input data together with the results of simulations of historical floods enable us to estimate behaviour of the catchment in different periods. Further work will be now concentrated on the error of the simulation of the flood events (mainly the peak discharges), which is necessary for the evaluation of the simulation of future potential flood events based on ALADIN climate scenario. It is necessary also to analyse the past from the point of view of return time period peak discharges in important profiles.

The study of climate change impacts on the quality of surface water resources in the Vltava River basin (Czech Republic) started according to the work plan within two tasks: analysis of natural conditions, land use, water quality, and water management and setup, calibration and validation of hydrological and water quality models. The modelling system consisted of two models – the precipitation-runoff and water quality model in the river network (HSPF) and the reservoir hydrodynamics and water quality model (CE-QUAL-W2).

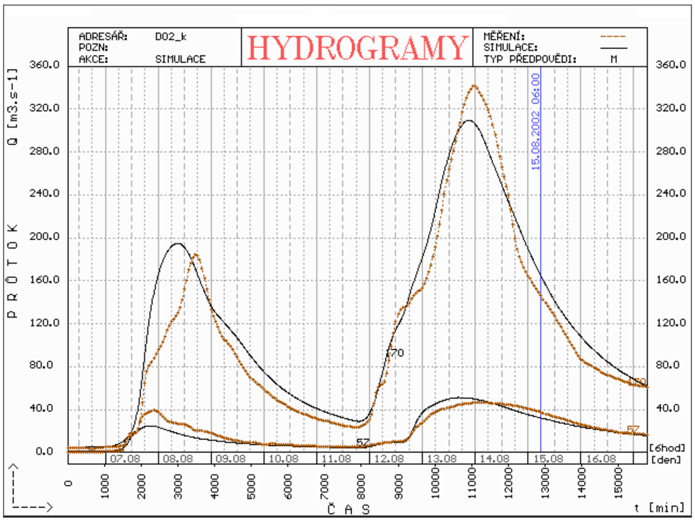


Figure 34: *The flood event August 2002 - the simulation of discharge in Janov profile (no. 57) and Podhradí profile (no. 170) made by HYDROG model compared with measurement (brown color).*

For the HSPF model the data on precipitation, potential evaporation (PET), and temperature in a daily time step were used as model inputs for the period 1961–2004. Daily precipitation amounts were acquired from 49 precipitation and climatic stations. Missing values (35%) were filled in by the method of nearest neighbour combined with simple linear regression. Then precipitation for each sub-basin was calculated according to method of Thiessen polygons. Daily PET was computed by the approach of FAO Penman-Monteith equation for reference crop from air temperature, relative humidity, cloud cover, and wind velocity datasets. Wind velocity was replaced by 12 average monthly values for 61–04 period to achieve homogeneity of calculated evapotranspiration. PET was corrected for each simulated sub-basin by a multiplicative coefficient (1.0–1.9) in the calibration procedure. The air temperature from the CB station was shifted in the HSPF model internally (module ATEMP) in the dependence on the median elevation of sub-basin (lapse rate 0.55–0.6 °C/100 m). As example Fig. 35 present the results of HSPF model calibration for mean monthly flow in one of catchments of the Vltava River basin. The agreement between the simulated and observed values was acceptable in all profiles. The relative error ranged from 0.03 to 0.21 and the Nash-Sutcliffe coefficient from 0.51 to 0.77. The HSPF model was calibrated against daily datasets of flow with various lengths (9 to 44 years) in respect to the gradual development of the observation network.

Simulations of water quality constituents (suspended solids, phosphorus fractions) in the runoff were highly dependent on the correctness of flow modelling. HSPF/CE-QUAL-W2 modelling system was calibrated and validated for simulations of both, hydrology and water quality at the sub-basin of the deep, Rimov Reservoir, where sufficient data existed for this purpose. Temperature stratification and water column mixing in the reservoir were simulated quite realistically. Phosphorus concentration (which is the key factor for eutrophication and water quality in all reservoirs of the Vltava River basin) was reproduced with a partial success – the timing of seasonal pattern and summer concentrations were modelled correctly but the size of concentration amplitude during the winter period was biased. In spite of this partial imprecision of the model system is suitable for the planned impact studies (see Fig. 36).

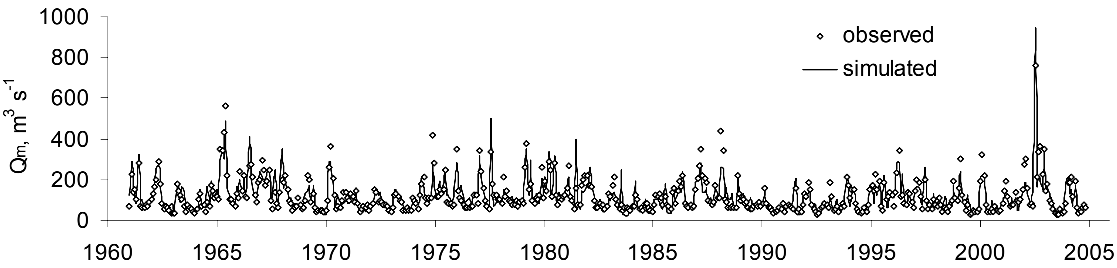


Figure 35: *Comparison of HSPF-simulated and observed mean monthly flows at Vltava-Vrane gaugestation*

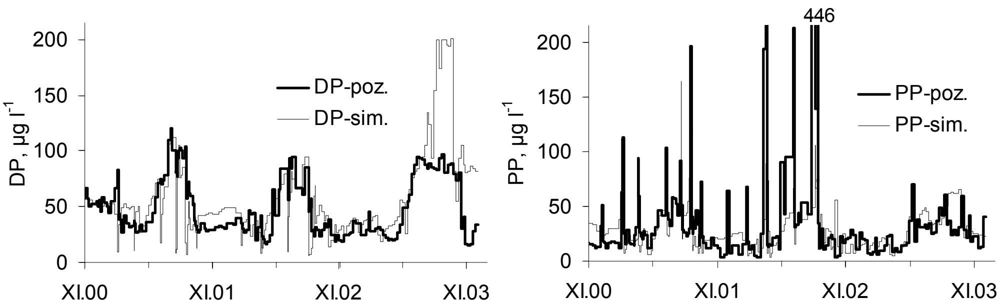


Figure 36: *Observed and simulated concentrations of DP and PP in the main inflow into Rimov Reservoir (profile Malse-Poresin)*

The comparison of observed and simulated water temperatures (Tw) and concentrations of DP, TP, and ChlA in Rimov Reservoir with the model system HSPF–CE-QUAL-W2 is given in Fig. 37.

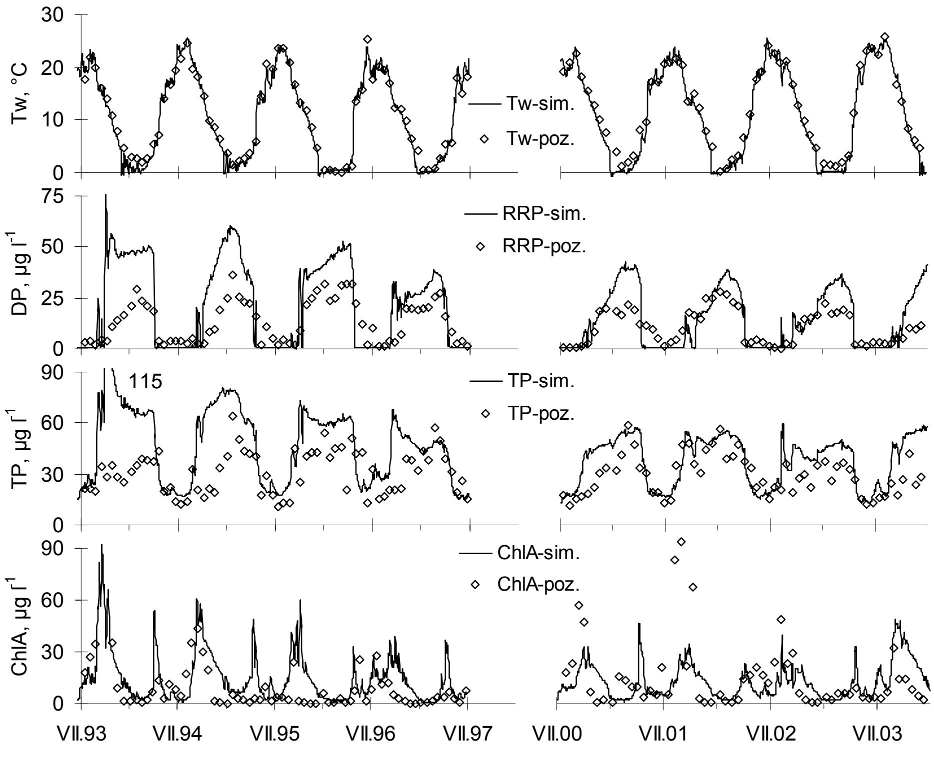


Figure 37: *Observed (poz) and simulated (sim) parameters, for calibration and validation periods*

The model efficiency and reliability of simulations were evaluated by selected statistical parameters: mean values of observed (AVG-poz.) and simulated (AVG-sim.) values, mean of absolute error (AME), root mean square error (RMSE), mean relative error (RE), and Nash-

Sutcliffe coefficient of model efficiency (NS; Nash and Sutcliffe 1970) that gives values close to 1 for good agreement between observed and simulated values and values <0 for simulations that have lower prediction force than the mean of observed values.

For calibration of the hydrological balance model KVHK applied for Hron river basin (Slovakia) the mean monthly precipitation for the sub-basins, the mean monthly discharges in the sub-basin outlets and the mean monthly potential evapotranspiration (PET) in the sub-basins were used. For calculating the potential evapotranspiration, the Tomlain method based on the Budyko methodology has been chosen and additional climate data for this purpose were collected: the mean monthly air temperature values, the mean monthly values of the relative air humidity, the monthly values of cloudiness and number of days with snow cover in a month. Sub-basin's average values of monthly precipitation totals and mean monthly air temperature were estimated by the method of Thiessen polygons. Daily precipitation data for the study area are measured in 44 raingauge stations; daily temperature data are available from 12 climatic stations. Long term monthly potential evapotranspiration data according to the Budyko method is available at the climatic stations.

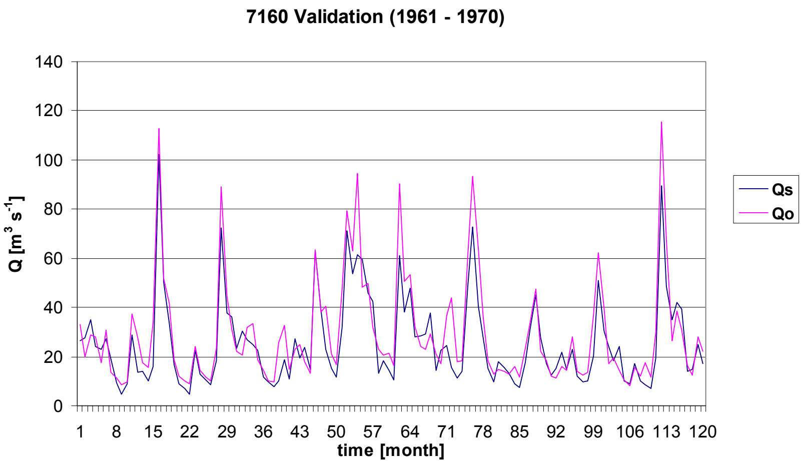


Figure 38: *Comparison of simulated (Qs) and observed (Qo) mean monthly discharges at the Hron – Banská Bystrica gauging station for the validation period 1961-1970*

Table 6: *Model parameters for the Hron – Banská Bystrica sub-basin*

eps	2.185
alpha	1.44
Smax	225
Zinitial	0.994
T_l	4.924
T_s	-4.983
gamma	1.798
PeffPar	0.866
ActEpar	0.968
Rb	0.089
Drc	0.006

The KVHK hydrological balance model was calibrated and validated in selected sub-basins of the Hron river basin on data from the period of 1971-2000 (calibration period) and 1961-1970 (validation period). Three sub-basins have outlets directly at the Hron River (Brezno, Banská Bystrica and Brehy), the others represent the Hron river tributaries. Most of the selected sub-basins can be considered as uninfluenced; only 2 sub-basins are influenced by water reservoirs. Time series of simulated and observed mean monthly discharges for the calibration and validation period are compared (see Fig. 38). For all sub-basins, the model performance was optimized by the Nash-Sutcliffe optimization criterion. In Tab. 6 values of Nash - Sutcliffe criteria are summarized for the calibration and validation periods in all selected sub-basins. According to this criterion and also to the graphical comparisons of simulated and observed mean monthly and long-term mean monthly discharges, a good performance of the model almost in all sub-basins can be confirmed.

For studying the impact of a potentially altered climate on runoff from analysed Romanian river basins, Buzău and Ialomița, WatBal model have been used for the simulation of the runoff in 17 cross-sections on the period 1971-2000. This model contains some parameters related to direct runoff (β), surface runoff (ε), sub-surface runoff (α and γ); maximum catchment water-holding capacity (field capacity) (Smax) and base flow (Qb). Accordingly for the analysed river basins was used monthly time step. For the computation of effective precipitation in periods where snowmelt makes up a substantial portion of the runoff water, a temperature index model was used with the upper (3°C) and lower (-3°C) temperature bounds defined by "trial and error" method.
In the WatBal model runoff from impervious surfaces (direct runoff) is controlled by means of β coefficient. The value of this parameter is estimated based on basin characteristics like urbanization and development. Its value should probably be no greater than 0.15 or 15%. In this study was considered β=0. Surface runoff is described in terms of the water storage state in soil, z, the effective precipitation and the base flow, having like parameter ε coefficient. Larger values of ε correspond to the situation in which the water storage in soil becomes very small, so that the surface runoff tends to zero, ε coefficient should not grow much larger than 5. Sub-surface runoff is a function of the relative storage state times a coefficient, α. Larger values of this coefficient correspond to an increase of the sub-surface runoff. In most cases, the value of the power term on sub-surface runoff γ is 2, value which was considered in WatBal model applied in the analysed river basins, Buzău and Ialomița. Another model parameter is S_{max}, which is defined as the maximum storage volume, so when S_{max} is multiplied by z, the current storage volume for the period is given. The storage variable z is given as the relative water storage state ($0 \leq z \leq 1$). The S_{max} parameter will likely range between 150 and 700 mm. The initial storage Z_i has been determined during the calibration process by comparison for the first month of the simulated discharge hydrograph with the measured one. The base flow, in this study, has been estimated as approximately 95% low flow. The parameters of the WatBal model were calibrated using an unconstrained heuristic algorithm which finds an optimal set of model parameters while meeting the criteria of minimizing the root mean square error between the measured and simulated monthly runoff value. The direct runoff coefficient β and the power term on sub-surface runoff γ are not part of the optimisation routine.

Time series inputs in the WatBal model need for the calibration of the model parameters in the river basins Buzău and Ialomița include precipitation, temperature and relative air humidity, sunshine hours, wind speed and discharges in the analysed cross-sections. Mean monthly values of temperature, relative air humidity, sunshine hours and wind speed registered at the 18 meteorological stations for analysed sub-basins have been used, for the computation of the monthly precipitation on each sub-basin corresponding to the 17 cross-sections additionally registered values of 89 pluviometric stations have been used. Note that for the period with missing observations at some meteorological stations, the values have been determined on the basis of some correlations using the values from proximate meteorological stations from respective point.

The optimum values of the parameters of the WatBal model for the cross-sections considered in the river basins Buzău and Ialomița are presented in the Tab. 7. As example, in Fig. 39 the mean monthly discharge hydrographs for the period 1971-2000 at the hydrometric station Racovita on the Buzău River are presented. The errors between the measured and simulated discharges using WatBal model was estimated by means of the root mean square method and the NTD criterion.

Table 7: *Calibration values of the WatBal model parameters*

River basin	*River*	*Cross- section*	Z_i	Q_b *(mm/zi)*	S_{max} *(mm)*	β	ε	α	γ
Buzău	Buzău	Nehoiu	0.34	0.289	350	0	0.73	7.96	2
		Măgura	0.49	0.233	335	0	1.25	2.83	2
		Banița	0.44	0.139	400	0	1.89	1.0	2
		Racoviță	0.37	0.089	455	0	2.32	0.98	2
Ialomița	Ialomița	Moroeni	0.57	0.365	395	0	1.64	2.01	2
		Târgovişte	0.63	0.170	420	0	2.15	0.4	2
		Bălenii Români	0.59	0.107	580	0	3.14	0.22	2
		Siliştea Snagovului	0.74	0.059	685	0	6.28	0.43	2
	Prahova	Adâncata	0.59	0.239	475	0	2.60	0.51	2
		Câmpina	0.51	0.459	420	0	1.67	4.53	2
		Halta Prahova	0.67	0.333	395	0	1.80	1.0	2
	Teleajen	Gura Vitioarei	0.64	0.082	400	0	1.61	3.20	2
		Moara Domnească	0.65	0.264	405	0	2.80	0.54	2
	Cricovul Sărat	Ciorani	0.59	0.052	660	0	3.22	0.04	2
	Ialomița	Coşereni	0.54	0.153	460	0	2.45	0.52	2
		Slobozia	0.57	0.106	580	0	3.70	0.50	2
		Țăndărei	0.35	0.101	605	0	3.0	0.5	2

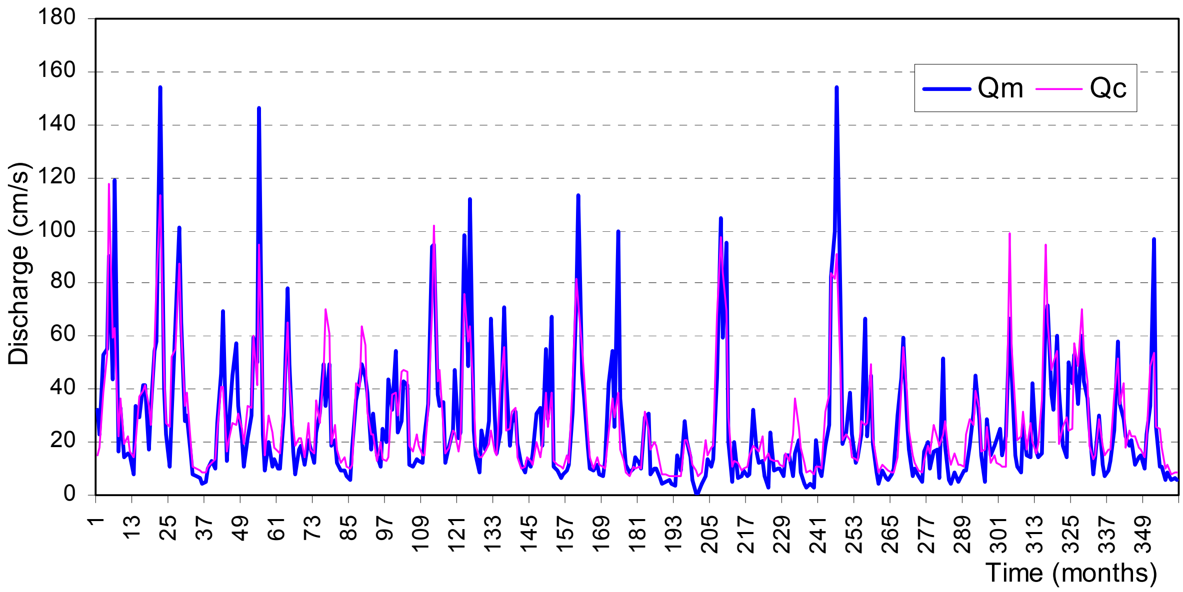


Figure 39: *Measured (Qm) and simulated (Qc) mean monthly discharge hydrographs in the period 1971 - 2000 at the hydrometric station Racoviță on the Buzău River*

After the analysis of the hydrological simulation results obtained in the calibration process, the following major conclusions can be drawn: (i) The acquired results of the WatBal model parameters calibration by means of runoff simulation in 17 cross-sections from Buzău and Ialomița river basins show that the model behaves fairly well given its simplicity. This is confirmed by the values of the NTD parameter, which are over 0.7 exceptions with Nehoiu hydrometric station on the Buzău River, Moroieni hydrometric station on the Ialomița River and

Gura Vitioarei hydrometric station on the Teleajen River. (ii) WatBal model proved to be very sensitive to the definition of effective precipitation, where 1-2 degree variation can be significant in the representation of snow melt, which is used to derive effective precipitation. (iii) Therefore, the strong seasonal variation in runoff in the analysed river basins points out the need for possible seasonal parameters within WatBal. However, we may assume that empirically based models, that have been regionally developed and calibrated, can give superior results over a physically based model, which might eliminate the need for additional model parameters. (iv) WatBal model performed well on a monthly time step especially where precipitation was relatively uniform over the year (snowmelt processes were not important) and dramatic runoff changes were largely attributable to evapotranspiration.

For the Deliverable D5.3 dealing with the analysis of natural conditions, climate, hydrology, development of land use, surface water quality and water management during the period from the 1960s to the present the studies of natural and man-induced variability in the climate conditions, runoff and water quality in the river network and water management of analysed river basins were performed.

The Dyje catchment is located in the south-eastern part of the Czech Republic and as mentioned earlier covered with the fields and forests as the prevailing landuse. In the Czech Republic almost all the water is drained off to the other countries. So that, the water resources are dependent prevailingly on precipitation. The most floods are caused by snow melting in February and March. From the point of view of hydrological extremes – the annual and monthly peak discharges - it is quite well known that the period till 60's was more balanced than the period 1970-2006, which shows the periods of low and very high discharges. From the historical point of view we can say that extreme floods are not a new phenomena in the Dyje catchment. Nevertheless, in the last five years three huge floods occurred in this catchment – after more than 50 years of, from the point of view of hydrological extremes, a relatively balanced period. From the point of view of hydrological extremes, since 1960 the peak discharges seems to be lower, the exceptions are two significant floods which occurred in 1985 and 2006. The water management in the Dyje catchment is influenced by 20 reservoir, which were built in the period from 1896 to 1990. Their total volume is 527 mil m3. The largest change in recent period is caused in lower part by the system of three reservoirs called Nové Mlýny followed by Vranov and Dalešice.

The Vltava River basin is situated in the southern part of the Elbe River basin. The area of the studied part of the basin with the closing profile at Vrane n/V. is 17,793 km^2. The altitude of this part of the basin ranges from 190 to 1378 m a.s.l. Geography includes different climate, geological, hydrological, and land-use conditions in a spectrum of locations ranging from river valleys and upland plains that are largely used for agriculture and urbanisation to forested, almost uninhabited mountainous parts. The river network includes four major rivers: the Vltava River with its two right-side tributaries and one left-side tributary. A large part of the Vltava River valley is impounded with a cascade of reservoirs that have been built for a hydropower production as main purpose. In addition, two important drinking water reservoirs are situated on side tributaries. The area is dominated by a crystalline of the Vltava-Danube area known as moldanubicum. The geology is varied with several units ranging from Proterozoic to Tertiary (Quaternary) age.

The upper Vltava River basin belongs to the temperate, mildly cold climatic region. It is situated in a transient region between a wet oceanic climate of the west Europe and a dry continental climate of the east Europe. A long-term annual mean precipitation amount is about 680 mm. The distribution of precipitation amounts across the basin is uneven with more than 1,000 mm at the southern mountainous part and about 600 mm in the central and northern parts of the basin. The annual mean temperature is about 9°C at the lowest parts of the basin and <5°C at altitude above 1,000 m a.s.l.. A highly significant increasing trend of temperature was detected at most climate monitoring stations in the basin during the period from 1961 to 2004 with an annual increase by 0.02 to 0.03°C.

The population of the basin increased by 8%, during 1961-2004. A major increase occurred in the 1970s, reflecting the fact that a strong age classes that were born in the first decade after the World War II reached the reproduction age. The standard of living improved significantly during 1961-2004 and the economic structure changed. The sector of agriculture employed less people, which induced moving of people from small countryside settlements and villages into larger centers and cities. Natural background concentrations can be inferred from the profile Vltava-Pekna that is situated in the predominantly forested catchment (72%) with low farming intensities (meat cattle production on pastures) and low density of population. The Vltava River experienced a period of heavy organic pollution from a paper mill situated at Vetrni (cca 30 km downstream from Lipno Reservoir) until 1990. The pollution with nitrate and phosphorus peaked during the early 1990s. The largest amount of water in the Vltava River basin is used for hydropower production. The hydropower use does not change the total amount of runoff, however, it modifies its temporal distribution. The most important withdrawals within the Vltava River basin are due to the use of water in drinking water production, cooling systems of power plants, heating plants, and industrial production.

The Hron River is a left-side tributary of the Danube River, its basin is located in Central Slovakia. The catchment is feather-shaped, located along the long main river with numerous shorter tributaries. It covers an area of 5465 km^2, its upper and middle parts are situated in the area of Inner Carpathian Mountains, while the lower part of the basin belongs to the Danubian Lowlands. The River Hron itself springs in the Slovenske Rudohorie Mountains at an elevation of 934 m a.s.l. and joins the Danube river at Sturovo (103 m a.s.l.). The length of the river is 284 km. Topographically the basin can be conceptually divided into three individual parts with a rather different character depending on the properties of the relief, geological structure and geological history of the territory.

With regards to the availability of hydro-meteorological data and also according to the character of the hydrologic processes in the catchment only the two upper regions are suitable for conceptual water balance modelling with a monthly time step. The alluvial part of the river has not sufficient data suitable for modeling (short series and less a dense network), but due to its lowland character and very low specific discharge (mostly less then 1.5 l/skm^2), modelling approaches have to be applied, which better account for the physically based description of processes in the unsaturated zone than the WATBAL model and other conceptual monthly water balance models. The lowest reliable discharge gauging station on the main river is at Brehy. This station was selected as the closing cross section for the CECILIA project (the term “Hron River basin” refers mainly to the Hron catchment to Brehy hereafter). This subcatchment has an area of 3 821 km^2 (8% of the Slovak territory). Elevation ranges from 195 m a.s.l. at the catchment outlet to 2 043 m a.s.l. on the peak of Ďumbier in Nízke Tatry Mountains on the north. In the description of hydrological conditions, basic characteristics of the Hron River and its tributaries, slope conditions of river Hron and its tributaries, discharge characteristics in selected profiles in the Hron basin, water balance characteristics of Hron and its tributaries in the period of 1931-1980, and available meteorological and hydrologic data were reported. Daily precipitation data for the study area are measured in 44 raingauge stations; daily temperature data are available from 12 climatic stations. Long-term mean monthly potential evapotranspiration data calculated by Tomlain and Damborská according to the Budyko method were also available for comparison is available at the climatic stations.

2.5.3 Deviations from workprogramme

The works are performed following working plan achieving the requirements of the Milestone M5.1. There is slight delay in calibration of the runoff model for Dyje catchment, the work on a few subcatchments hs not completed yet. Despite of that, all the deliverables are available, although for D5.2 in draft mode, waiting with final version till this delay will be removed which is supposed in Month 15. This small delay does not imply any problem or delay in further work for the project.

2.6 WP 6

2.6.1 Workpackage objectives

The objectives of WP 6 consist of assessments of climate change impacts on selected agriculture crops, forest ecosystems and carbon cycle, including other risks of climatic variability. These are related to climatic extremes with special focus on drought, which is considered to be the most important climate hazards for plant production under the expected climate change. From biotic agents the special attention is paid to the future extend and potential damage caused by the pest and diseases. Main tasks as defined in DoW are:

- Assessment of the change in crop yield and its quality under the different climate scenarios for the selected regions under current production and land-use systems.
- Assessment of the change in forest tree growth under the different climate scenarios for the selected regions under current management systems.
- Assessment of climate change effects on soil water balance: the water use and loss in agricultural crop production and drought impacts on growth and development of the agricultural crops.
- Sensitivity analysis of the selected agriculture crops and the most vulnerable forest stands to climate change impacts
- Expected changes of occurrence and activity of pests and diseases on selected crops and forest ecosystems
- Integrated assessment of climate change and air pollution impacts on forest ecosystems in selected region
- Impacts of climate change on C-cycle in agriculture and forest ecosystems
- Adaptation analyses, recommendations and development of management options for improved land use systems in agricultural crop production and forest management under the regional climate change scenarios.

The emphasis in the first reporting period has been given to the first two, the main effort was given to the preparation of the data and models for selected species, which have to be calibrated for the purposes of the model with respect to defined domains of interest and ecpected high resolution of the inputs.

All the institutions involved had rather good experiences with climate change related research before the project had started. A series of national and international projects provided a proper starting point for impact studies within the CECILA project. In the field of agriculture the members of WP 6 project team (FRI as the coordinator, IAP, ELU, BOKU, NMA, CHMI, WUT, NIMH) have been closely cooperating with each other in the Central European target region since early 1990´s through national and international projects (e.g. COST 718, preparation of COST 734).

For forestry the main activity has been performed by FRI, the institute of the National Forest Centre supported by the Ministry of Agriculture of the Slovak Republic, being active in climate change related research in the field of forestry. Spectrum of technical facilities for forest growth monitoring, water balance, genetics, etc. are located at series of plots and research areas over the whole country. Comprehensive forestry database supervised by National Forest Centre provide detail information of forest stands by individual forest compartments, inclusive data on dynamics of injurious agents. National Forest Inventory provides extra set of parameters at 4x4 km grid. All these data were used in previous climate change impact studies and are available for CECILIA purposes.

As for carbon cycle part of the tasks,mainly ELU with support of OMSZ has been involved in several greenhouse gas related national and international projects providing good starting points for CECILIA project (e.g. FP6 integrated project CARBOEUROPE). The tall tower CO_2 (and other greenhouse gases) monitoring station of Hungary equipped with instruments enabling measurement of the carbon dioxide exchange between the atmosphere and the biosphere is the base of all the studies.

2.6.2 Progress towards objectives

Similarly as in previous “impact” WP, main emphasis was given to the preparation of crop and forestry data and models for selected species, which have been tested and calibrated for domains of interest. The progress towards actual as well as towards the next periods objectives will be described in the terms of Deliverables and Milestones for the first reporting period. The two deliverables have been submitted and two milestones were planned to take important project decisions.

The Deliverable D6.1 summarizing the previous studies on effect of climate change on crop yield and forest tree growth was submitted in Month 12 of project lifetime, i.e. with the delay that will be described later. It describes the target regions for climate change impacts analysis, proposed models and algorithms; and available data sets. Climate change impacts on selected crops, forest tree species and carbon cycle were evaluated as well. The contractors involved are IAP, BOKU, FRI, NMA, ELU, NIMH.

For agriculture NIMH made an analysis of Bulgarian domain of interest selected for this project, which is the North-East NUTS2 region covering 19 973 km2 or 18% of the Bulgarian total area. A strongly developed agricultural sector is the region's major advantage, crop production in particular flourishing due to the favorable climate and the region's vast plains. However, the region has limited water resources. Daily weather data for the period 1961-2000 were gathered. The Data Distribution Center (DDC) of the Intergovernmental Panel on Climate Change (IPCC) provided the 30-year averaged transient GCM monthly meteorological outputs The MAGICC software and the SCENGEN model database were used to generate climate change scenarios for the Balkan Peninsula. Soil, phenological, agrotechnological and crop yield data were obtained from the Bulgarian National Variety Commission of the Ministry of Agriculture. DSSAT CERES and RoIMPEL crop models were calibrated and validated under the current climate conditions. There was found good agreement between real phenological stages and yield of important crops in the selected region and phenology and yield, estimated with the CERES and the RoIMPEL models. The results obtained indicated a satisfactory performance of the applied simulation models for winter wheat and maize in the selected environments.

Changes in crop growing season, crop yields as well as adaptation options for crops under various climate change scenarios were studied. It was found that the sowing dates of spring crops in Bulgaria could shift under the GCM climate change scenarios in order to reduce the yield loss caused by an increase in temperature. Another option for adaptation is to use different hybrids and cultivars. There is an opportunity for cultivation of more productive, later or earlier-maturing, disease- and pest-tolerant hybrids and cultivars. Switching from maize hybrids with a long to a short or very short growing season projected an additional decrease of final yield under a potential warming in Bulgaria. Technological innovations, including the development of new crop hybrids and cultivars that may be bred to better match the changing climate, are considered as a promising adaptation strategy.

For the Czech territory, based on the preliminary simulation the south and south-eastern part of the Czech Republic was selected by IAP as a target region. It is adjacent to the target areas in Austria and Slovak Republic and is consistent with the project proposal. Moreover, all analysis and model runs have been integrated to the NUTS 4 regions in order to provide outputs usable directly by decision-makers and in the same time provide reference with historical statistics to verify the models. In order to explore the effect of climate change on cereal production the following crop models will be used: CERES-Barley, CERES-Wheat and CERES-Maize. They perform better than other tested tools i.e. WOFOST, SWAP or STICs (however in some cases other crop models will be used as well). Experimental data used for the multi-year model evaluation were derived from 19, 7 and 2 experimental sites for spring barley (234 experimental years), winter wheat (75 experimental years) and grain maize (28 experimental years) using the field trials of the State Institute for Agricultural Supervision and Testing (SIAST). The model calibration was followed by the evaluation of the model performance with the extensive independent data sets originating from the remaining set of stations with wide range of environmental conditions. Calibration and evaluation were focused both on the phenological development (anthesis and maturity dates) as well as on the production parameters (yield, weight of 1000 seeds and number of grains per sq. m). The first experiments for climate change conditions used Global Circulation Models (CSIRO-Mk2, CGCM2, GFDL-R30, HadCM3, CCSR/NIES, ECHAM 4), SRES A2 emission scenario and weather generator for time slices of 2025, 2050 and 2100 (Note: because of the time constraint the models from the 3rd IPPC report were used in the first runs). The results were interpolated into a 1x1 km grid matrix using ArcInfo GIS software and only grids covered by arable land and analyzed further. Combination of the changed climatic conditions and increased CO_2 concentration on crop yields would lead to the positive trend in the grain yields. If the fertilizing effect is not included the wheat, barley and maize yields would reach 25-98% of the present values while when the stimulating effect is accounted for yields might increase by as much as 25% by 2100 in comparison with the present conditions. Despite differences between individual regions the trend seems to be positive across the whole Czech Republic. However there are large regional differences that will be investigated further using also new set of GCM from the 4th IPPC report. One of the working hypothesis for the future work is the assumption that the slight increase of yields of rainfed winter wheat, spring barley and maize (thanks to positive effect of CO_2 and improvement of climate in higher altitudes) might be eliminated by climate extremes occurrence especially by drought in the presently most productive regions. As economical units in agriculture (i.e. farms) are usually confined to one regional climate the ongoing analysis will focus on the smaller regions.

Drought evaluation has been based on Standardized Precipitation Index (SPI) and Palmer Drought Severity Index (PDSI), which might be used for both types of the comparative studies: either to compare drought conditions at different sites during a given period or to compare drought conditions for a single site but during different periods. The other approach using the Enhanced Newhall Simulation Model (ENSM) enables to model the annual soil moisture regime (by USDA soil classification) and allows exploring of frequency and probability of appearing soil moisture regimes and events. If we combine Global Circulation Models with drought indices we can evaluate drought occurrence, frequencies and duration of individual drought spells. First results indicate negative trends for changed climate conditions in all characteristics and a notable gradual increase of the areas with a high probability of drier soil regime was noted. The ongoing improvement of Newhall model will result into a completely new version that will be ready by August 2007.

The last risk for crop production related to changed climate that is considered by the IAP group includes is the spatial extent of a climatically suitable area for a pest and diseases. In the initial stage of the project the methodological approach was tested on the European corn borer (ECB, *Ostrinia nubilalis* Hubner), which is the most dangerous pest of corn. It was chosen because of its nearly global presence, adaptation potential, and its expected sensitivity to climate change within regions of Central Europe. By 2025, the flight initiation of the ECB could take place, on average, 4-10 days earlier than during the reference period (1961-2000), and the ECB life cycle will be completed 9-15 days earlier. The effect of climate change on the ECB climatic niche is profound and similar results are expected for other species included in the CECILIA pest portfolio (e.g. Colorado Potato Beetle or Potato Blight). In most cases the climate change will lead to an earlier beginning of the growing season and will accelerate pest development or intensity of infestation.

Similarly, since new climate change scenarios for this project were still missing, already available regional scenarios for north-east Austria were used to perform the first simulations by BOKU for their domain of interest in NE of Austria. These scenarios are based on IPCC IS92a scenarios, which were realized with the ECHAM4/OPYC3 global circulation model (GCM). 500 potential years were calculated for the period 2020 (mean between 2010 and 2030) as well as for the period 2040 (mean 2030 and 2050). According to this scenario annual temperatures are expected to rise around 1.9°C in the 2020s and 2.5°C in the 2040s in the selected region. Precipitation variation was not included in the regional scenario.

Winter wheat growth and development for the experimental field were simulated for climate change scenario representing (i) climate effect of a change in weather input [only air temperature according to scenario] compared with the present climate but no change in CO_2 concentration in the atmosphere (330 ppm), (ii) climate effect of a change in weather input [air temperature according to scenario and precipitation (increase and decrease of 20% precipitation in respect to the present conditions)] compared with the present climate but no change in CO_2 concentration in the atmosphere (330 ppm), and (iii) climate effect of a change in weather input [air temperature according to scenario and precipitation (increase and decrease of 20% precipitation in respect to the present conditions)] compared with the present climate and CO_2 effect in the atmosphere (year 2020 = 429 ppm and year 2040 = 495 ppm)

Table 8: *a) statistical summary of climate change scenario and CO_2 effect for 2020*

	temperature	precipitation - 20 %	precipitation + 20 %	$C0_2$ * 1.3 (429 ppm)	$C0_2$ * 1.3 (429 ppm) +20% prec.	$C0_2$ * 1.3 (429 ppm) -20% prec.
Yield [kg ha^{-1}]	5821	5091	6022	6248	6368	5519
Stan.dev.	1222	1650	1069	1147	1022	1564
%change in respect to the present climate	+2.1	-10.7	+5.6	+9.6	+11.7	-3.2

b) statistical summary of climate change scenario and CO2 effect for 2040

	temperature	precipitation - 20 %	precipitation + 20 %	$C0_2$ * 1.3 (459 ppm)	$C0_2$ * 1.3 (459 ppm) +20% prec.	$C0_2$ * 1.3 (459 ppm) -20% prec.
Yield [kg ha^{-1}]	5954	5204	6105	6596	6501	5921
Stan.dev.	1439	1792	1290	1451	1262	1734
%change in respect to the present climate	+4.5	-8.7	+7.1	+15.7	+14.1	+3.9

In Tab. 8 the different results of winter wheat yield [kg ha^{-1}], the standard deviation and the percentage change in respect to the present climate are summarised. The climate change scenarios for near future show the greatest effect when CO_2 increases. Up to 15% more yield can be expected when CO_2 increases by 50% until 2040. Simultaneously the standard deviation increases and consequently the yield variability. This provides a higher yield risk for the farmer. Occurrence of pest and diseases due to climate change effects were not included in the simulations.

NMA provided the analysis in their region of interest, the large agricultural region in the south-eastern Romania, with high importance for crop production, particularly for wheat and maize. Analysis of historical soil moisture data, crop development information, and yield production showed that the selected area for CECILIA project is vulnerable to climate change, in particular in respect to drought effects. The multi-annual average values (1970-2000) of the in-situ measured soil moisture at specific calendar dates were used to delineate the different classes of soil water availability for plants as shown in Fig. 40.

Winter wheat, 30 June | Maize, 31 August

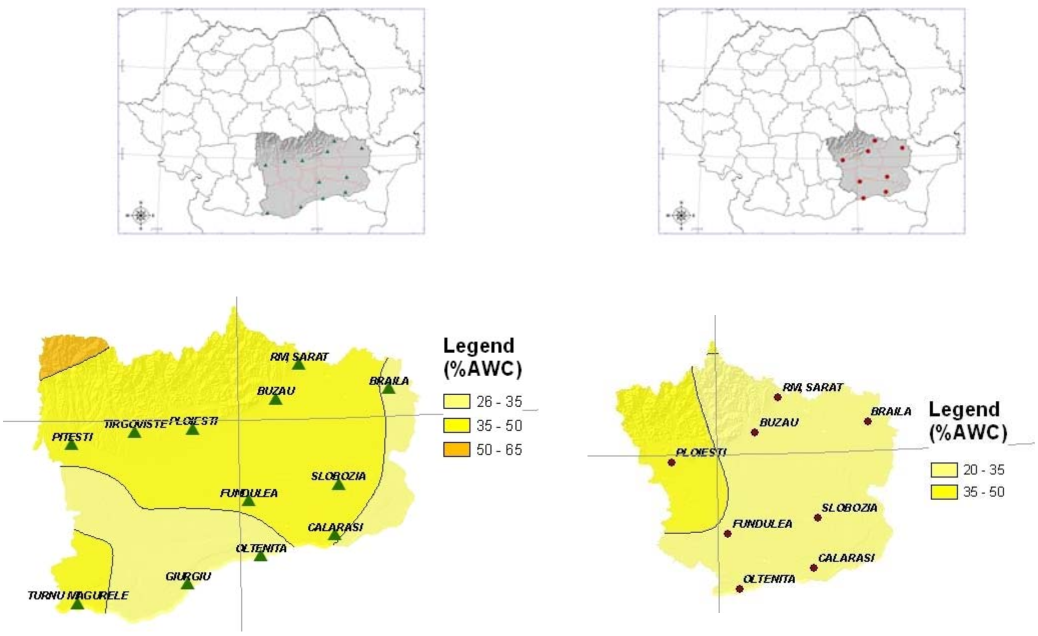
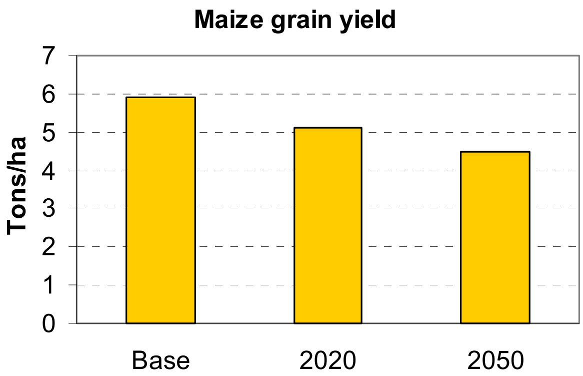
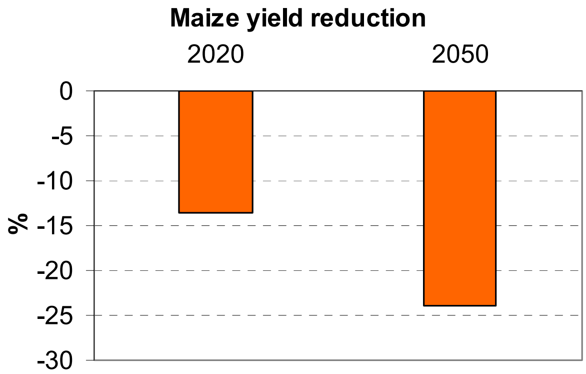


Figure 40: *Multi-annual average (1970-2000) soil moisture spatial variability within the selected region, at specific dates for winter wheat and maize, respectively*

An investigation with HadCM3 2020 and 2050 climate scenarios and CERES-Maize model resulted in maize yield decreases of 14% in 2020 and 24% in 2050, compared with the 1961-1990 period, for the pilot station Calarasi. Yield reduction occurs due to shorter grain-filling periods, caused by the higher temperature and lower rainfall. The maize growing season becomes significantly shorter with 10 days in 2020 and with 16 days in 2050 (Fig. 41 and 42).

In addition, outputs from global climate model HadCM3 (SRES scenario A2) were used to create climate change scenarios for two-time periods in the future (2010-2039 and 2040-2069), centered on the decades 2020s and 2050s, in order to assess the change in growing season length of the maize crop, at the pilot station Calarasi. The CROPWAT model was run for 30 years, with baseline climate and climate change scenarios. The changes in growing season evapotranspiration, crop water requirements, crop irrigation requirements/soil moisture deficit and changes in percentage of yield reduction were quantified. Calibration of CERES and CROPWAT models for the current climate (1961-1990) data will be continued with the rest of the selected stations, for both maize and winter wheat crops, and predictions for the mid-century (2020-2050) and end-century (2070-2100) time-slices will be performed at the two pilot stations, Calarasi and Buzau, using the climatic data provided by the regional models running on climate change scenarios.





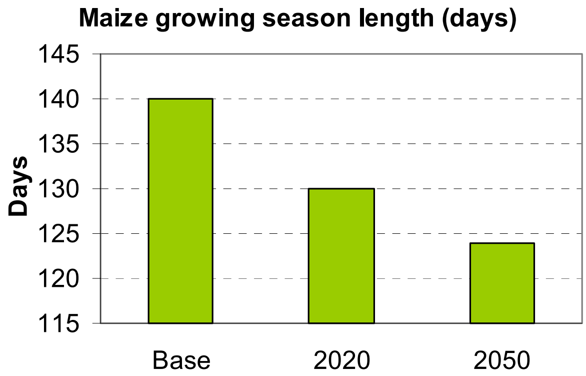


Figure 41: *Changes in the maize yield (upper left), relative reduction of maize yield (upper right) and maize growing season length of rainfed (right) crop under HadCM3 scenarios (decades 2020 and 2050) as compared with the baseline period (1961-1990), at Calarasi*

For Slovakia, crop, soil and meteorological dataset validation of CERES-Maize model on sandy-loam soils of Danubian lowland and heavy soils of East-Slovakian lowland, regions of interest for the project, were prepared by FRI. According to inputs on weather, physiological, soil and agrotechnical data, there were built a dataset for simulation using program ICSim. This integrates all input data mentioned and enables running required simulations. These were made for years 2001-2004. The potential maize grain yields – output from a model, were compared with measured grain yields from the years 2001-2004. Field trials consist of 3 subvariants (B1 conventional tillage, B2 rational tillage, B3 tillage with dish harrow) differing in amount and type of applied fertilizers.

Crop yields of cereals (barley, wheat, maize) simulated by DAISY were validated on experimental yields from the field stationary experiment in Most near Bratislava from the years 1973 – 2006. The seven irrigated treatments and seven treatments without irrigation with different fertilization by N, P and K we considered in the experiment. Various crop varieties were grown during this period. Available regional scenarios for Slovakia were tested for climate conditions up to year 2050 (1,5xCO_2). These are based on SRES scenarios, which produced using CCC2000 global circulation model (GCM). Remarkable decrease of maize grain yield in Nitra region (North of Danubian lowland) was recorded. Shortening of the growing season will decrease grain yields. Positive effect of CO_2 on photosynthesis will probably slightly suppress this negative trend. Anyway grain yields will probably decrease from 14519 $kg.ha^{-1}$ (in conditions of $1xCO_2$) to 11960 $kg.ha^{-1}$ (17.62 %) in time horizon 2050 ($1,5xCO_2$). If the acclimation effects occur it is possible that yields decline on 11440 $kg.ha^{-1}$ (-21.19 %). Within testing adaptive measures for reducing negative impacts of climate change the best solution seems to be the shifting the date of planting determined by days with air temperature exceeding 12 °C. Even under this adaptation, decrease in grain yields to 12000 $kg.ha^{-1}$ in 2050 can be expected. On the other hand, higher stability of grain yields is expected, where deviations from average values varied in a range ± 14 %. In the case of variants with date of planting exceeding 10°C this reached ± 18,5 %. All the crops without irrigation showed a higher variability in yields. The direct yield forming effect of CO_2 was manifested mainly through increased maximum yields that were achieved in years with favorable water and nutritional regimes. The fertilizing effect of the atmosphere was more apparent on the increased green matter. Thanks to the fertilizing effect of CO_2 higher yields might be expected, however, higher inputs are required. On the contrary, insufficient nutrition – mainly on less fertile soils – and lack of water in Lowlands will result in reduced yields.

For forestry three forest regions were considered by FRI and proper models, methods and algorithms proposed as required by the Milestone M6.1. All data needed for climate change impact analysis in the next periods were gathered, checked for consistency and compiled. Oak, beech and spruce ecosystems, as widely spread and economically the most important forest tree species are analysed. Two approaches were used to model the climate change impact on forest tree growth. Experimental use of tree growth simulator proved significantly decreased total volume production as well as total current increment in spruce, beech and oak stands (except for spruce stands in higher elevations, where living conditions appear to improve). All changes differ significantly from species growth under normal climate (period 1951-1980). Analysis of spruce and beech growth responses to climate gradients confirmed the results obtained using the growth simulator, i.e. deteriorating conditions for growth of target species under climate change scenarios. Proved significant responses of used models to changing climate allow for simulating with high-resolution climate data produced by WP1 and WP2 in the next project periods. Tree growth simulator was adapted to enable these data be flexibly integrated. Thus all the simulations with changing climate parameters under various management techniques might be evaluated in the next periods.

ELU has made the contribution with the preparation for analysis of carbon cycle. Calibration of the BIOME-BGC model is inevitable for future carbon cycle impact studies, because the model is generalized and cannot be used for site-specific simulations with its original parameterization. As the model has 31 internal parameters we sought for a method that is applicable even with this large number of parameters. Firstly, the number of model parameters to be calibrated must be reduced in order to reduce the computational time. We applied a simple sensitivity analysis based on the Monte-Carlo method, where the model parameters are varied separately and the standard deviation of the output (GPP and R_{eco}) is calculated. The results were used to rank the parameters. Secondly, a methodology is needed that can be used to choose the most appropriate sensitive parameters so that the model results would match the measurement data. Maximum Likelihood (ML) method and also Bayesian parameter estimation (BPE) method were chosen to calibrate the model. Both methods (ML and BPE) use a so-called likelihood function that describes the distance between the measured and modeled quantities. The likelihood function is the function of the mismatch between measurements and model output weighted by the measurement error. In order to calculate an appropriate likelihood function the distribution and standard deviation of the measurement error must be investigated. In order to estimate the measurement error we developed a methodology, which uses the similarity in the environmental parameters (radiation, temperature, phonological phase). This was necessary since there is no uncertainty estimate in the literature (at least to our knowledge) that could be used to describe eddy covariance based measurement uncertainty in daily timesteps for GPP and R_{eco}. Our next step will be the application of the ML and BPE methods to find the most appropriate parameterization of BIOME-BGC that describes present day carbon exchange for the Hegyhátsál grassland and mixed agricultural region.

The second Deliverable D6.2 providing information on the drought damage potential and crop water use efficiency as influenced by climate change effects and regional conditions was submitted in due time, i.e. Month 12 of project lifetime. In order to asses vulnerability to drought phenomenon spatially and temporally, historical data of precipitation, soil moisture, and crop water requirements were analyzed for the target areas. Various simulations for climate change scenarios were also performed for estimation of drought impact on agricultural production. Soil characteristics for most of the regions were taken into account for differentiated estimations according to local conditions.

The target area selected for the study by BOKU was the Marchfeld region, one of the most important agricultural production areas in Austria. The DSSAT CERES model was used in order to determine the vulnerability of current agricultural management systems for the selected crops. Winter wheat (*Triticum aestivum* L.) cultivar "Capo" was calibrated as a cultivar; it is currently grown on large acreages in the Marchfeld. Regional climate scenarios for NE Austria were used to perform the simulations. These were carried out with the CSIRO, HadCM and ECHAM global circulation models (GCMs), based on SRES-A2 emission scenario. Soil classification in the region was taken into account in order to differentiate the drought impact on the crop production depending on the soil characteristics, which are extremely important for water retention and water availability to plants. The findings of the study suggest that, on soils with total available water capacity over 140 mm, mainly other factors than physical soil conditions (precipitation, nutrients etc.) will be the relevant limiting factor for crop development in average years. It was also found that in general, the Water Use Efficiency of the plant (WUE_{plant}) will enhance. Higher CO_2 concentration will enable the plants to reduce stomata opening and water losses. The plant stands on light soils show the highest WUE_{plant} increases compared to the present conditions. This means the wheat plants have to deal with stronger water scarcity on light soils. WUE_{field} (also includes evaporation) will increase especially on medium soils. On light soils shallower stands lead to higher evaporation losses. The ratio between actual and potential evapo-transpiration was used as a measure of drought stress. For all soils lower values were calculated for the climate scenarios. Low values are related to higher drought stress for the plants, whereas light soils show a higher increase of stress than medium soils. Despite higher drought stress winter wheat yields increase due to compensation by higher CO_2 concentrations (except very light and shallow soils).

For Bulgaria spatial distribution of precipitation during different seasons was applied to classify the drought risk of the NUTS4 units in Northeast Bulgaria by NIMH. It was found the most vulnerable regions are the eastern territories of the considered region. The selected region was also classified according to soil type, structure and moisture content. The DSSAT Seasonal Analysis program was used to simulate different components of the soil water balance during the crop-growing season of maize from 1961 to 1997. There is an obvious increasing trend in the number of irrigation applications during the last two decades. Most of irrigation totals anomalies were also positive during the last considered years due to significant precipitation reductions across the country. Most of the seasonal surface runoff anomalies during the period 1961-1997 were negative because of some significant positive anomalies and especially lower precipitation in the 1980s and 1990s. Irrigation strategies for maize – case studies under current and expected climate change conditions were performed by the DSSAT CERES model.. The major goal was to determine the most appropriate timing and water amount of irrigation applications, the emphasis of both biophysical and economic analyses were done.

In Slovakia FRI adapted their analysis to the new actual agro-climatic regionalization (based on data from years 1961-1990) and to the new classification of climatic characteristics related to traditional agricultural zones proposed in this period. On these bases, Danubian and East-Slovakian lowlands were recognized as the most vulnerable agricultural areas of Slovakia. Climate change impact studies were based on SRES scenarios based on CCC2000 global circulation model (GCM). Evapotranspiration and precipitation characteristics during growing seasons were used to define conditions of drought under $1xCO_2$ and $2xCO_2$. Drought conditions were evaluated from the view of temperature and water balance during growing seasons. Difference between potential evapotranspiration and rainfalls is significantly changing along the altitudinal profile. High totals of potential evapotranspiration during so short time period as GS10 period (as compared with GS5 period), can evoke conditions of drought on lowlands of Slovakia. More significant changes were calculated for lowlands of south Slovakia (+30 %), under $1xCO_2$. Zero values of index will shift from altitude 550 to 650 high above see level. Changes of this index are even more significant for GS10, as compared with GS5. There was found increase of the index by 90 – 100 mm on lowlands (+32 - +45%) under $2xCO_2$. Zero values of the index will shift from altitudes 550 m to 700 m.

Analysis of historical soil moisture data (1970-2000) for Romanian regions of interest by NMA revealed a high vulnerability to drought of the target area with high intensity and prolonged droughts having a relatively high frequency, and multi-annual average values of available soil water being below the winter wheat and maize crop requirements at most of the critical dates for plant development. The drought phenomenon in Romania, although without a strict cyclical character, generally shows repeatability at 15-25 years intervals. Average yields of winter wheat and maize crops in droughty cycles are only 35-60% of the yields which could be obtained under complete provision of crop water requirements by irrigation. A more detailed analysis focused on 4 consecutive droughty years 1999-2003, period that emphasises the trend of warmer and dryer years, particularly in the target area. The evolution of crops in terms of phenological phases and final yield was analyzed during drought periods and it could be concluded that water stress, many times associated with thermal stress during droughty years result in forcing of phenological phases, alteration of grain filling processes, thus reduction of quality and quantity of the yield. The thorough analysis of recent prolonged droughts (i.e. 1999-2003) provides important information about crop-weather interaction during such extreme phenomenon, giving the opportunity to assess more accurately the impact of future climate change on agricultural production, as well as possible solutions to be applied drought mitigation.

In Czech Republic the drought impact analysis performed for the target areas (four regions were in various agricultural regions of the Czech Republic) in the framework of CECILIA project by IAP, was based on the ***relative indices***, which can be used either to compare drought conditions at different sites during a given period or to compare drought conditions for a single site during different periods. In order to describe changes in the soil moisture regime a new version of Newhall Soil Moisture Regime model (NSMR-3) have been developed partly with the support of the CECILIA project. The relationship between the crop productivity and meteorological drought were evaluated, followed by the assessment of frequency and impact of drought stress on the winter wheat and spring barley, using a dynamic crop growth model to pinpoint the areas most at risk from drought (in 1x1 km resolution) for the present climate as well as limited set of climate change scenarios. Drought indices indicate that during next 50-100 years Czech Republic will be faced with dry episodes of intensity and duration that were not usual in past 100 years. The area at risk from drought episode will widen and the drought will be more intensive but the extent is highly sensitive to the scenario used. These changes would activate multilevel cascade of changes affecting e.g. the landscape water balance, nutrient cycling or composition of soil organisms. Soil would become drier in general thus increasing drought risk and drought vulnerability of the area. The change is unavoidable but its magnitude depends on future emissions of greenhouse gases.

Despite of the delay of the Deliverable D6.1 that will be explained later the requirements of the the Milestone M6.1 were achieved in due time during the first period. Thus, each partner has identified and described the model regions, where all impact studies are intended be carried out. The six agriculture regions (CZ, BG, RO, AU, SK), three forest regions (SK) and one site for carbon cycle analysis (HU) were proposed and described. Sufficient records on climate, crop yield and forest growth, management techniques, pests and diseases dynamics as well as on carbon cycle are available for all the regions. GIS tools, models and specific algorithms to model climate change impacts were proposed and described. CERES and Daisy models are proposed for climate change impact analysis on crop yield and other parameters. Newhall soil moisture model and selected drought indices will be used for drought assessment. SIBYLA tree growth simulator was proved be an efficient tool for climate change impacts analysis on tree growth and further parameters of forest trees and stands. BIOME-BGC model will be used for climate change impact analysis on carbon cycle. Other specific algorithms are proposed for analysis of expected changes of occurrence and activity of pests and diseases on selected crops and forest ecosystems. The decisions taken in order to select the representative model regions and to prepare proper models and methods are key for advanced analysis of climate change impacts in next periods.

For the next Milestone M6.2 calibration and validation of selected models (water balance, drought indices and growth) for the main selected crops, crop rotations and forest ecosystems were performed and finally delivered. As crop simulation models, CERES and Daisy has been calibrated and validated successfully in selected regions for several crops. Respective parameters are given in deliverable D6.1. Sufficiently long and reliable climatic, agrotechnological, soil and crop records allowed for highly accurate calibration in all cases. For drought indices, the self calibrated Standardized Precipitation index, Palmer drought severity index and Palmer Index were tested at number of CZ and AU stations (50 + 10 respectively). In the same time the CECILIA is the first EU project using the newly introduced *relative indices* (rSPI and rPDSI), that were developed at IAP. They might be used for both types of the comparative studies: either to compare drought conditions at different sites during a given period or to compare drought conditions for a single site but during different periods. Soil moisture was included to the analysis by means of Newhall soil moisture model. The Enhanced Newhall Simulation Model (ENSM) enables to model the annual soil moisture regime (by USDA soil classification) and allows exploring of frequency and probability of appearing that soil moisture regime events. The model have been originaly developed in monthly time step by USDA and is being redeveloped in the daily time step at IAP. The model has been so far tested in CZ and AU with planed extention in the CECILIA domain. Up to now results of runs in the forms of maps including whole CZ for 5 GCM-based climate change scenarios (CSIRO-Mk2, CGCM2, GFDL-R30, HadCM3, CCSR/NIES) and assuming A2 and B1-SRES emission scenario for time slices of 2025, 2050 and 2100 have been made available.

In forest applications tree growth simulator Sibyla was proposed with appropriate models and methods for climate change impact analysis on the growth of selected trees. Tree growth simulator was calibrated and validated using data from 1189 forest monitoring plots in Slovakia. Actual tree increments from repeating measurements and tree increments derived from the simulator have been compared. Totally, 7358 trees of spruce, 1137 trees of fir, 1181 trees of pine, 9213 trees of beech, and 3444 trees of oak from permanent monitoring plots were used. Final calibrated equations were implemented into the simulator.

For carbon cycle BIOME-BGC model with 31 internal parameters has been adopted. Sensitivity analysis to reduce this number and thus the computational time based on the Monte-Carlo method was applied using variation of the parameters. The results were used to rank the parameters. A proper methodology is needed to choose the most appropriate sensitive parameters so that the model results would match the measurement data. Maximum Likelihood (ML) method and Bayesian parameter estimation (BPE) method were chosen to calibrate the model. In order to estimate the measurement error we developed a methodology, which uses the similarity in the environmental parameters (radiation, temperature, phonological phase). This was necessary since there is no uncertainty estimate in the literature (at least to our knowledge) that could be used to describe eddy covariance based measurement uncertainty in daily time steps. The next step will be the application of the ML and BPE methods to find the most appropriate parameterization of BIOME-BGC that describes present day carbon exchange for the Hegyhátsál grassland and mixed agricultural region.

In addition to WP6 tasks for this period, remarkable progress has also been achieved in the preliminary analysis of climate change impacts on selected pests and diseases for agriculture and forest regions, which is compliant with D6.5 *„Expected changes of occurrence and activity of pests and diseases on selected crops and forest ecosystems“,* and in the preliminary analysis of climate change impacts on carbon cycle in one model region (Hungary). This task is compliant with D6.7 *"Integrated assessment of climate change and air pollution impacts on C-cycle in agriculture and on forest ecosystems".* Moreover, the analysis performed for D6.1 and D6.2 in this period provides good starting point to the D 6.8 concerning the recommendations and development of management options for an improved land use systems in agricultural crop production and forest management under the regional climate change. Similarly, the Deliverable D6.6 dealing with the sensitivity analysis of the selected agriculture crops and the most vulnerable forest stands to climate change impacts as well as D6.7 on the integrated assessment of climate change and air pollution impacts on C-cycle in agriculture and on forest ecosystems directly build on the progress achieved in this period in D6.1.

Moreover, Warsaw University of Technology (WUT) was not planned to participate in WP6 deliverables in the first reporting period. However during the first year of CECILIA project, WUT analyzed the geographical distribution, seasonal phenology and health condition of Polish forests. Special attention has been paid to the forest localized in Polish National Parks. The availability of historical data, which will be crucial for assessing further calculations, were also reviewed. These include localization of emission sources, air pollution and meteorological monitoring stations (insolation, temperature and precipitation measurements) as well as forest defoliation data. The selection of forest regions have been made - the forested areas at Sudety mountains at south-western Poland was chosen. The area spread over a part of the so-called "*Black Triangle*" region, situated on the junction of Czech Republic, Germany and Poland. After the results of air pollution simulations for future climate will be known, WUT might decide to include also another region.

2.6.3 Deviations from workprogramme

As the leading person of WP6, Dr. Josef Mindas (FRI) was appointed another duties last autumn and resigned from the responsibilities for the project without proper reporting due to some ucertainities, there were a gap in managing of the activities and collecting the information. Thus, the Deliverable D6.1 "*Report about the results of the crop yield and forest tree growth changes influenced by climate change, regional conditions and management systems"* scheduled at 6th month of project lifetime was delayed, although most of the work was already done. After the formal information that Dr. Josef Minďáš does not act as WP leader since January 2007, the discussion at project meeting and decision of Scientific Steering Committee at Semmering, new FRI coordinator Dr. Tomáš Hlásny was accepted to take a lead of WP6. Actual submission date of D6.1 was finally Month 12 of project lifetime All the tasks have been carried out according to deliverable objectives. There are no consequences for other tasks of the project from this delay of delivering the information, work on the workpackage is continuing smoothly as seen from other deliverable and milestone achieved in due time.

2.7 WP 7

2.7.1 Workpackage objectives

The main goal of the third impact workpackage WP7 is to investigate the impact of the anticipated future climate change on air quality and health. Nowadays, people are constantly and nearly all over the world exposed to air pollutants, whether indoors or outdoors. Climate change may affect exposures to air pollutants by many ways. Change in temperature patterns is affecting air emissions, both anthropogenic and natural. Weather is strictly associated with energy demands (e.g. for space heating and cooling) that could alter patterns of fossil fuel combustion, including adaptive responses involving increased fuel combustion for fossil fuel-fired power generation. Local weather patterns - including temperature, precipitation, clouds, atmospheric water vapor, wind speed, and wind direction - influence atmospheric chemical reactions; they can also affect atmospheric transport and deposition processes as well as the rate of pollutant export from urban and regional environments to global scale environments. In addition, the chemical composition of the atmosphere may in turn have a feedback effect both on global and local climate.

The health effects of air pollution are broad and diverse, including dramatic episodes of increased mortality at high concentrations of some species. In humans, the pulmonary deposition and absorption of inhaled chemicals can have direct consequences for health. Nevertheless, public health can also be indirectly affected by deposition of air pollutants in environmental media and uptake by plants and animals, resulting in chemicals entering the food chain or being present in drinking-water and thereby constituting additional sources of human exposure. Furthermore, the direct effects of air pollutants on plants, animals and soil can influence the structure and function of ecosystems, including their self-regulation ability, thereby affecting the quality of life (WHO, 2000). The most sensitive groups include children, older adults and persons with chronic heart or lung disease.

The individual tasks of the WP7 were defined by DoW:

- Exploitation of the sensitivity of air-pollution levels to potential climate change based on data analysis of long simulations of offline chemistry air quality models (AQM) driven by Regional Climate Models (RCMs) for present climate and for future projections.
- Comparison of air-pollution levels simulated by online and offline regional air-quality models during certain episodes of the present climate.
- Estimation of the key species exceedances of the EU limits for the protection of human health, vegetation and ecosystems as well as WHO guidelines for present climate and for future projections.

All six participants from 5 countries, i.e. WUT from Poland (leader of WP7), CUNI and CHMI from Czech Republic, BOKU from Austria, NIMH from Bulgaria and AUTH from Greece, had got already a great experience with Air Quality (AQ) modeling for local and regional scale when the project started. These participants had some experience with regional climate modeling as well. The starting point was to join these experiences to realize modeling of the interaction between climate and air quality by predictions of air pollution levels and loads in the target regions in Central and Eastern Europe on the fine scale (10 km x 10 km) of the Regional Climate Models' (RCMs).

2.7.2 Progress towards objectives

During the first reporting period in addition to the preparation of the measurement data, both pollutants concentrations and emission inventories, WP7 had a main objective defined in the

Deliverable D7.1, i.e. coupling of the AQM's to the RCM's by development of the pre-processors to convert RCM-output to AQM-input. This deliverable led by BOKU was completed and submitted in Month 12 of the project. Moreover, Milestone M7.1 required to make a selection of the air-pollution episodes to be simulated from the offline and online chemistry AQMs. The milestone led by AUTH was completed and is presented herein.

Air quality depends on many anthropogenic as well as climate factors. To exploit the sensitivity of air quality to potential climate change, Regional Climate Models (RCMs) simulations for future projections and for the control period have to be used to drive offline Air Quality Models (AQMs). To start with all WP7 tasks, all partners involved had to choose their modeling tools for coupled regional climatic and air quality simulations as well as their modeling domains. Three couples as modelling tools for fine scale (10 km x 10 km) simulations will be used. RegCM coupled to CAMx (Comprehensive Air quality Model with eXtensions (CAMx, freely available at http//www.camx.com, from ENVIRON International Corporation, Novato, California) will be used by BOKU, CUNI and WUT for their regions of interest. In addition, for the Czech domain ALADIN-Climate will be coupled to CAMx by CHMI as well, finally, ALADIN-Climate coupled to CMAQ Model (Community Multi-scale Air Quality), available from US EPA, http//www. epa.gov/asmdnerl/ CMAQ/CMAQscienceDoc.html will be used by NIMH for Bulgarian domain. Moreover, BOKU and AUTH will use the offline couple RegCM - CAMx for full Europe simulations in 50 km to provide the information on the continental scale and to prepare boundary conditions for chemistry in local simulations.

For the first deliverable of WP7 the interface between RegCM and CAMx was written by CUNI and provided to AUTH, BOKU and WUT. For more detailes, the description of the interface and first experiments see D7.1. Moreover, coupling between ALADIN-Climate and CAMx is in the final stage of preparation at CHMI and modifications to move to RCM application are adopted in prognostic version of ALADIN - CMAQ couple at NIMH. For further application, as considered in other deliverables, AUTH and BOKU assembled ICTP RegCM@50km data from ENSEMBLES run for the year 2000. At BOKU, anthropogenic emissions for the year 2000 on the 50 km grid that can be combined with biogenic VOC emissions from the RegCM/CAMx interface were prepared and distributed to AUTH and CUNI. Coupled models (RegCM-CAMx) test runs were performed in 50km resolution at AUTH and BOKU. As a result of this common effort the AQ photochemical models were prepared for their further tasks, in particular the preparation of European background concentration runs in 50 km resolution, due to Deliverable D7.2 by month 18 of the project. Additionally, the first test runs will be used for the validation of the model systems.

It is now well established that climatically important (so called radiatively active) gases and aerosols can have substantial climatic impact trough their direct and indirect effects on radiation, especially on regional scales (Qian and Giorgi, 2000, Qian et al., 2001, Giorgi et al., 2002). The study of these effects requires coupling of regional climate models with atmospheric chemistry/aerosols to assess the climate forcing to the chemical composition of the atmosphere and its feedback to the radiation, eventually other components of the climate system. For this coupling, existing regional climate model and chemistry transport model are used. At CUNI the same version of the model RegCM as for climatological runs in WP2 is used while chemistry is solved by the model CAMx. Support of the development of the couple ALADIN-Climate and CAMx as well for the purposes of the project is provided to CHMI.

For the project the interface or meteorological pre-processor for the coupling of the regional climate model with air-quality model was developed at CUNI (see D7.1). Meteorological fields generated by RegCM drive CAMx transport and dry/wet deposition. A preprocessor utility was developed for transforming RegCM fields to CAMx input fields and formats. Briefly, it takes RegCM's outputs and convert them to fields and formats accepted by CAMx. As the first step, the distribution of pollutants can be simulated for long period in the model couple. There are problems with the anthropogenic emission inventories available, at this stage emissions from EMEP 50 km x 50 km database are disaggregated. We are testing VOC speciation technique, biogenic emissions of isopren and monoterpenes calculated as a function of 2m temperature, global radiation and landuse by Guenther et al. (1993,1994). We use 23 vertical σ-levels reaching up to 70hPa, with time step of 150 s, at 45 km resolution in preliminary experiments for RegCM configuration available from previous experiments, the same horizontal grid for CAMx. Initial and boundary conditions are set to CAMx's top concentrations (independent of time) (Simpson et al., 2003) for 45 km resolution run, the results are used for driving the same couple of RegCM-CAMx in 10 km resolution on smaller "CECILIA" region. In our setting CB-IV chemistry mechanism is used (Gery et al.,1989).

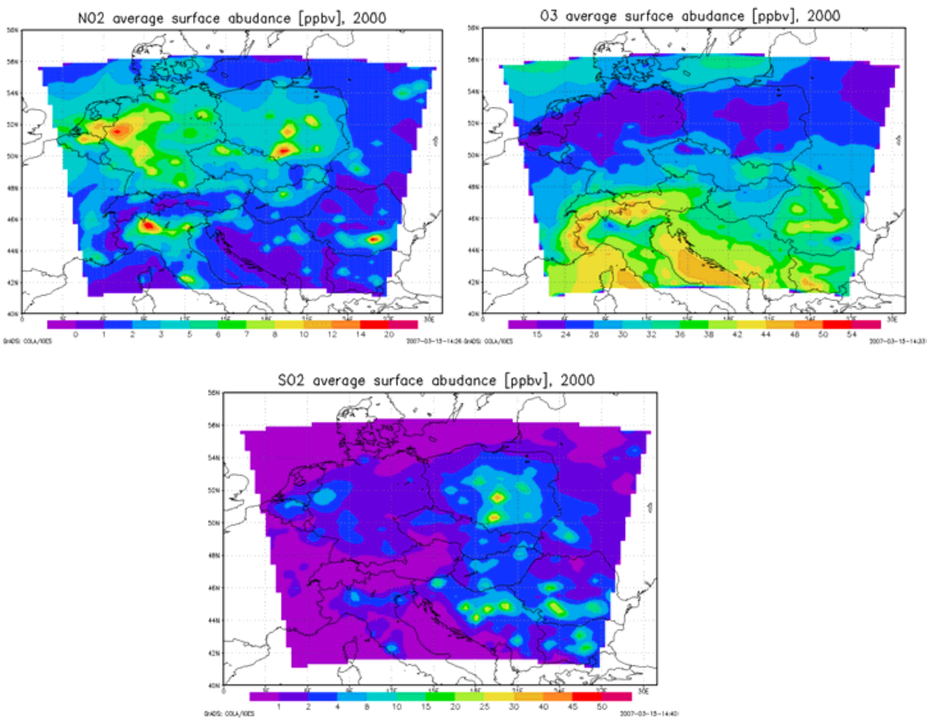


Figure 42: *Average concentration of NO_2 (upper left), O_3 (upper right) and SO_2 (bottom panel) for year 2000 in ppbv.*

An example of the interface working in high resolution integration for year 2000 is presented in Fig. 42 for selected species. There is much more local features seen in this simulation compare to less resolution run (not shown), especially for O_3 the effect of high resolution land use which provides basis for biogenic emission computation is well pronounced in the concentration fields, even more in summer (with respect to limited extent not shown again). More interesting comparison of the driving 45km resolution run with 10km high resolution run for selected stations can be seen in Fig. 43 in terms of time series of O_3 simulated concentrations with the comparison of both simulations with real data. Underestimation of the ozone concentration by the model especially during warm season appears for some stations of the Central Europe whereas overestimation is presented in comparison for Ispra mainly in cold period of the year. Basically, high resolution runs bring slight improvement of the results for selected stations.

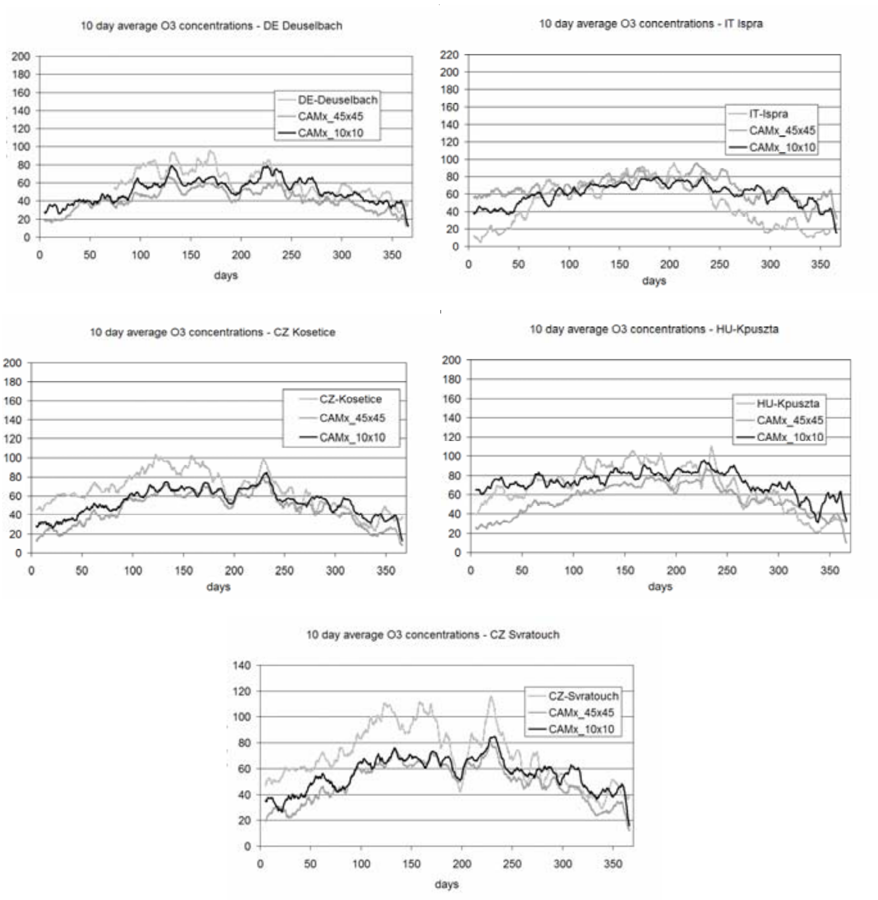


Figure 43. *Comparison of simulated and measured 10-days running average concentration of O_3 for selected stations in year 2000 ($\mu g/m^3$). Grey line for 45 km resolution, black line for 10 km resolution, light grey for measurement.*

To produce more reliable conclusions longer runs are essential. At present CUNI is preparing the longer experiment in very high resolution of 10 km driven by 50km run based on off-line simulation using CAMx by BOKU and AUTH with the meteorological data from ICTP RegCM simulation driven by ERA40 reanalyses done for EC FP6 IP ENSEMBLES.

At BOKU test runs of the CAMx model driven by meteorological fields from RegCM were performed for the year 2000. In the preparation of the runs the interface regcm2camx, provided by CUNI, has been installed. The anthropogenic emissions are calculated with the emission model of BOKU-Met based on data from the UNECE/EMEP data base. For every sector the emission model applies different distributions for the month, the day of the week and the hour of the day for the temporal disaggregation. 36 different sets of daily emissions were calculated, namely for every month these were three files containing weekday-, Saturday- and Sunday-emissions. Each set contains hourly emissions for every grid cell of the photochemical model. The NO_x and NMHC-emissions are also disaggregated chemically. A disaggregation of $PM_{2.5}$-emission will follow. By a small intermediate piece of code is possible to add to these files the day specific biogenic emissions of isoprene and terpenes that depend on the meteorological data and were calculated with the regcm2camx routine. The emission data and the intermediate programme were also used by AUTH. The meteorological input data were provided by AUTH. BOKU performed several sensitivity runs for the whole year of 2000 with different sets of data for the concentrations of species at the lateral boundaries and the top of the model. The model results were compared to available measurements of air pollutants and to other models. In discussions at the CECILIA workshop at Chalkidiki it was decided to continue the work with clean air conditions at all boundaries.

The major goal of CHMI participation in WP7 during the first year of CECILIA project has been to try preparation of coupling between RCM ALADIN and photochemical dispersion model CAMx. Due to more reasons, this task has been proven to be challenging. Firstly, ALADIN-Climate is relatively young RCM and has not been used for air pollution experiments yet (neither in its NWP version in sense of published results). So that, the necessity arised to prepare preprocessor based on that one used for MM5/RegCM type models in close cooperation with CUNI. Secondly, family of ARPEGE/ALADIN models works with its internal data format unsuitable for direct use by CAMx or other applications. Moreover relatively high vertical resolution (43 levels) of ALADIN model necessary for proper representation of troposphere processes increases amount of data to be processed as the input for CAMx model. Thirdly, model ALADIN-Climate does not produce neither prognostic nor diagnostic cloud water/ice and does not provide optical depths - necessary inputs for CAMx model - a problem which must be dealt within its preprocessor. However, up-to-date NWP versions of ALADIN already parameterizes those quantities directly and this has been finally applied in climate version. Thus, the couple has been assembled from model ALADIN-CLIMATE based on NWP ALADIN version CY28 T3 in recent weather forecast operational use at CHMI and developed in frame of international consortium led by Meteo-France primarily as a tool for short range weather forecast, and Eulerian photochemical dispersion model CAMx, version 4.40 developed by ENVIRON Int. Corp. For testing and control purposes year 2000 from ALADIN-CLIMATE ENSEMBLES 25 km resolution simulation has been selected (in accordance with other participants). Those data are saved on central CHMI storage silo and are available for other CECILIA partners (NIMH) on request.

The Air Quality Model, which AUTH applied for the study of climate change impacts on air quality was the Comprehensive Air Quality Model with extensions version 4.40 (CAMx) as well. This model was adapted to meteorological input coming from Regional Climate Model simulations with RegCM using CUNI interface. A full year simulation of the regional climate model RegCM3 was carried out for 2000, forced by the ERA-40 reanalysis fields (2.5°x2.5°, L23 pressure level) of ECMWF for a large European domain with a grid resolution of 50 km x 50 km. The Global Ocean Surface Temperature (GISST), a set of SST (Sea Surface Temperature) data in monthly 1° area grids, was used to constrain the SST of the RegCM3 simulation. GTOPO30 Terrain and GLCC Landuse datasets, with 3 minutes resolution were used for the model topography and landuse respectively. The Grell scheme with Fritsch-Chappell closure was used for the convective parameterization of the model simulation. The map projection choice was Lambert conformal. The meteorological output fields of RegCM3 were used to drive offline the air quality model CAMx. CAMx run with coarse grid spacing over Europe in a spatial resolution of 50 km x 50 km, identical to the grid defined for the meteorological runs. The domain's vertical profile contained 12 layers of varying thickness, extending up to 450 hPa. Hourly anthropogenic emissions of gaseous and particulate pollutants were compiled and provided by BOKU. Biogenic emissions were calculated using the RegCM-CAMx interface in a 6-hour basis. Biogenic and anthropogenic emissions were combined with AddEmiss software developed by BOKU. All emissions were treated as surface area emissions. Initial and boundary (top and lateral) conditions corresponded to concentrations of clean air. The chemistry mechanism invoked was Carbon Bond version 4 (CB4). The results are discussed in the first deliverable of WP7 (D7.1) that was finished successfully.

During the first year of CECILIA WP7 activity, the major attention of WUT was put to preparation of AQ modeling tools to be used in further work. Instead of using CALPUFF modeling system from Earth Tech (formerly Sigma Research), as originally planned, we decided to apply the so-called *third generation* chemistry and transport model, namely CAMx, similarly as other partners are doing. Currently CAMx is used for air quality modeling in more than 20 countries by government agencies, academic and research institutions, and private consultants. It can use input fields from a number of meteorological as well emission models. Its abilities as well as flexibility encouraged us to implement the model to Polish area. During 1st year, the model was implemented to NW region of Poland (Zachodniopomorskie and Pomorskie voivodeships). This region was chosen, because we have the biggest possibility of input data collection, which is essential for validation of first model test runs. The emission submodel to CAMx was developed, taking into account point (industrial and energetic), area (municipal) and line (traffic) emission sources of the following species: SO_2, NO_x, PM10, PM2.5 and VOC. For every emission sector the model applies different time distribution. The emission registers for each type of emission in 1km, 5 km and 10 km resolution were prepared for chosen region. Also, the programs for preparing meteorological and emission input files for CAMx were written for Windows and Linux environments. Finally, the software package for post-processing the results (statistical analysis, visualization) was developed. In the preparation of the test runs the interface regcm2camx provided by CUNI has been installed.

The major goal of NIMH participation in WP7 during the first year of CECILIA project was preparation of coupling between climatic model ALADIN and AQM system. At NIMH air quality simulations will be performed using Community Multi-scale Air Quality model (CMAQ) developed at US EPA. The coupling at NIMH was realized as follows. Prognostic version of ALADIN produces output information every 6 hours. This data enter the MM5 meteorological model (PSU/NCAR limited-area, nonhydrostatic, terrain-following sigma-coordinate model designed to simulate or predict mesoscale atmospheric circulation), which prepares hourly meteorological fields as an input to CMAQ. The climatic ALADIN model ALADIN-CLIMATE is based on NWP ALADIN, hence have the same output as the prognostic one, so practically there will be no difference in coupling.

As clearly seen, the successfully completed Deliverable D7.1 is good starting point for further progress in WP7. However, more longer simulations is necessary to validate the technique and its feasibility in the evaluation of climate change impacts on air quality. Period of 10 years simulation covering years 1991-2000 will provide the comparison of reliable data both on input (emission databases) and measurement side. Further in framework of the CECILIA Project three time slices of 10 years are supposed to be completed in high resolution of 10km with the couple RegCM-CAMx: control (1991-2000), middle of the century (2041-2050) and end of century (2091-2100), using A1B scenario.

With respect to resources available only 10 years time slices are supposed to be run. However, as the episodes of high concentration are only rare and not so many can be expected to be involved for standard statistical postprocessing of the results, for Milestone M7.1 the selection of the air-pollution episodes to be studied and simulated by the offline and online chemistry AQMs was required. The main goal of this milestone is to prepare validation of air quality models coupled to regional climate models forced by ERA-40 data; for 1991-2001, where 1991-2000 represent the standard decade from past climate, and 2001 is additional year for models' verification purposes to cover more recent episodes supported with more and higher quality measurement data available from Central and Eastern Europe. This analysis is essential to estimate the appearance of the similar episodes in the future as well as to see the changes of thresholds giving then the similar frequencies of appearance. In addition to the episodes covered by this standard validation run the episode of strong heat wave of 2003 in most of Europe was selected for the special analysis of air quality condition under such an extreme conditions with implication for future warmer climate.

Four (out of six) partners chose episodes, i.e. the periods of time in past when high concentrations of primary (mainly SO_2 and PM10) or secondary (O_3) pollutants occurred. For Czech Republic and Poland episodes from 1997, 1998, 2000 and 2001 was chosen. They are described in Tables 1-5 given below.

Table 9: *Selected episodes in Czech Republic 1991 - 2001 (CHMI, CUNI).*

ozone

Year	Period	Duration (days)	Count of occurrence at stations (averg-min-max)	1-h information threshold value (180 µgm^{-3}) exceeding (µg*m^{-3})	Regions
1998	20. – 23.7.	4	2.25 – 1 - 3	184 - 213	SC,JM,SM
	8. – 13.8.	4	15 – 1 - 40	181 - 246	whole CR
	16. – 19.8.	4	4.5 – 1 - 14	181 - 199	PH,ZC,SC,JM,VC
2000	19. – 22.6.	4	13.7 – 5 - 23	191 - 256	PH,JC,JM,KH,LIB,MSL,OL,PA.SC.UL,VY
	13. – 21. 8.	4	2.75 – 1 - 13	187 - 257	PH,JM,KV,KH,OL,PA,SC,UL
2001	27.6.	1	5	160 – 169 *)	-
	31.7.	1	4	161 – 176 *)	-

*) Exceeding of 8-hour limit IH8h (160 µgm^{-3})

SO_2

Year	Period	Duration (days)	Count of occurrence at stations (averg-min-max)	24-h limit value (125 µgm^{-3}) exceeding (µg*m^{-3})	Regions
1997	1. – 8.1.	8		126 - 291	PH,ZC,SC,JM,SM

Source: CHMI, Air Quality Control Division

Another ozone episode occurred in summer 2003 will be covered by AUTH,. Although it is outside the standard decade of past climate, the climatic conditions were extremely unusual and hence analysis of such a hot spot of present climate give an excellent opportunity to investigate how regional climate/air quality simulations behave. A record-breaking heat-wave affected the European continent in summer 2003. In a large area, mean summer (June, July and August, referred to as JJA below) temperatures have exceeded the 1961-1990 mean by 3^{o}C, corresponding to an excess of up to 5 standard deviations. August 2003 was the hottest August on record in the northern hemisphere. An event like that of summer 2003 is statistically extremely unlikely, even when the observed warming is taken into account. Schär et al.(2004) demonstrated that in terms of temperature and precipitation the climatic conditions in JJA 2003 were not unlike those simulated by a regional climate model (RCM) driven by a greenhouse-gas scenario representing 2071-2100 conditions. Hence the heat-wave of 2003 offers a unique opportunity at AUTH group to test the RegCM3/CAMx offline simulations in a rather common climatic situation for the anticipated future climate of 2071-2100.

Table 10: *Selected episodes in Poland 1991 - 2001 (WUT).*

ozone

Year	Period	Duration (days)	1-h information threshold value (180 μgm^{-3}) exceeding (μgm^{-3})	Regions
1998	11. – 12.8.	2	184 - 192*	S Poland
	16. – 18.8.	3	**	S Poland
2000	19. – 22.6.	4	182 - 234	S and N Poland
2001	31.7.	1	182	S Poland
	20.8.	1	182	S Poland

data from Polish EMEP stations 1998-2001 (EMEP webpage).
*) Data from Śnieżka station (EMEP, PL03); other data have to be ordered
**) Data have to be ordered

SO_2

Year	Period	Duration (days)	24-h limit value (125 μgm^{-3}) exceeding (μg*m^{-3})	Regions
1998	24. – 27.1.	4	136 - 330	Central and S Poland
	25. – 27.11.	3	131 - 242	S Poland
	2. – 4.12.	4	157 - 219	S Poland
2001	17. – 23.1.	7	131 - 281	Central and S Poland
	5. – 10.12.	6	154 - 173	S Poland

PM10

Year	Period	Duration (days)	24-h limit value (50 μgm^{-3}) exceeding (μg*m^{-3})	Regions
1998	24. – 27.1.	4	225 - 348	Central and S
2001	17. – 23.1.	7	170 - 226	S Poland
	5. – 10.12.	6	123 - 326	Whole Poland

Source: *Air Pollution in Poland in 1998-1999*. Inspection of Environmental Protection, Warsaw 2001; *Air Pollution in Poland in 2001*. Chief Inspectorate of Environmental Protection, Warsaw 2002.

2.7.3 Deviations from workprogramme

During the first year of the CECILIA project, CHMI suffered from minor delay when working on Deliverable 7.1. This delay was caused by some personal changes at CHMI. At this moment, this delay is fully eliminated. No impacts of this delay are expected on the further work of CHMI and/or other CECILIA teams under WP7 tasks. The progress on all the work is in accordance to the workplan.

2.8 List of deliverables

Del. No.	Deliverable name	WP number	Date due	Actual/ Forecast delivery date[1]	Estimated indicative person-months	Used indicative person-months[2]	Lead contractor
D1	D8.1 Project web site established	8	Month 1	Month 1*	1	1	CUNI
D2	D8.2 Project Presentation	8	Month 4	Month 4*	1	1	CUNI
D3	D4.1 Measures and indices to be validated, which observational data sets to be used for the validation of extremes, plan of the analyses to be performed under D4.2, D4.3, D4.4, D4.5, and D4.6	4	Month 6	Month 6*	12	9.2	ETH
D4	D5.1Description of the rainfall-runoff models and of the reference basins, a revision of flood events from the analyze period, the input data, the schematization of the reference basins.	5	Month 6	Month 6*	16	5.3	NIHWM
D5	D6.1 Report about the results of the crop yield and forest tree growth changes influenced by climate change, regional conditions and management systems	6	Month 6	Month 6*	8	11.8	FRI
D6	D8.3 Workshop with potential endusers and stakeholders	8	Month 6	Month 12*	1	0	CUNI
D7	D1.1 Assessment of climate change information for CEE from previous projects	1	Month 12	Month 12*	12	11	ICTP
D8	D1.2 Provision of climate change information from previous projects for first-stream impact work.	1	Month 12	Month 12*	11	8.7	CNRM

[1] Asterisk marks the already completed deliverables.
[2] Number of person-months spent during the first reporting period.

D9	D3.1 Observed data for SDS models building, output localization, up-scaling, and model validation: station data and reanalysis data for SDS predictors	3	Month 12	Month 16	10	4.7	CHMI
D10	D5.2 Calibration of the monthly river flows over the selected period (1970-2000) and the rainfall-runoff models according to the flood events over the same period.	5	Month 12	Month 12*	18	7.4	NIHWM
D11	D5.3 Analysis of natural conditions, climate, hydrology, development of land use, surface water quality, and water management during the period from the 1960s to the present.	5	Month 12	Month 12*	20	2	FRI
D12	D6.2 Results of the drought damage potential and crop water use efficiency as influenced by climate change effects and regional conditions (IAP, BOKU, CHMI, NIMH, NMA, FRI).	6	Month 12	Month 12*	27	15.1	NMA
D13	D7.1 Coupling of the AQM's to the RCM's. Development of the pre-processors to convert RCM-output to AQM-input.	7	Month 12	Month 12*	26	21.9	BOKU
D14	D8.4 Progress Report 1	8	Month 13	Month 13	3	2.2	CUNI
D15	D1.3 ARPEGE simulation at 50 km grid for the 21st century under the A1B scenario for WP2	1	Month 18	Month 18	8		CNRM
D16	D1.4 RegCM3 simulation at 25 km grid for the 21st century under the A1B scenario for WP2	1	Month 18	Month 18	8	1.5	ICTP
D17	D2.1 RCM simulations forced by observations	2	Month 18	Month 18	35	15.7	CUNI
D18	D3.2 RCM output localization methods	3	Month 18	Month 18	16	2	BOKU
D19	D4.2 Analysis of observational datasets and of selection of pre-existing RCM data sets according to the decisions made in D4.1	4	Month 18	Month 18	28	4	DMI

D20	D5.4 Description, calibration, sensitivity and uncertainty analysis of the atmosphere-river network-reservoir modelling system and simulation of monthly river flow considering climate changes, comparison of results	5	Month 18	Month 18	6		IAP
D21	D7.2 Key species concentrations from the European runs for 4 * 10 years with 50 km resolution based on CBM-IV chemistry with sulphur, analysis of the output of the offline chemistry AQMs for future projections and for the control period.	7	Month 18	Month 18	17		AUTH
D22	D2.2 forcing files from ARPEGE for ALADIN runs	2	Month 19	Month 19	8	2	CNRM
D23	D2.3 forcing files from RegCM for RegCM runs	2	Month 19	Month 19	2		ICTP
D24	D2.4 RCM simulations forced by models	2	Month 24	Month 24	59		OMSZ
D25	D3.3 Assessment of the applicability of RCM and SDS models in the impact target areas by their validation according to relevant criteria; ranking of the models	3	Month 24	Month 24	22	4	IAP
D26	D4.3 Corresponding analyses of the CECILIA driving-model simulations, links between large-scale circulation patterns and extreme events	4	Month 24	Month 24	15		ETH
D27	D5.5 Present and future water demand.	5	Month 24	Month 24	2		NIHWM
D28	D5.6 Report on local air-sea interaction on the western Black Sea coast in present climate conditions.	5	Month 24	Month 24	6	3	NMA
D29	D6.3 Recommendations to improve effective use of water in the different production systems	6	Month 24	Month 24	15		BOKU
D30	D8.5 Progress Report 2	8	Month 25	Month 25	3		CUNI
D31	D2.5 production of the database	2	Month 26	Month 26	6	0.5	DMI
D32	D3.4 Climate change scenarios for near future (time slice 2020-2050)	3	Month 26	Month 26	18		NMA
D33	D3.5 Climate change scenarios for end of century (time slice 2070-2100)	3	Month 30	Month 30	18		ELU

D34	D5.7 Simulations of the sensitivity of reference basins using the balance between the demand and water resources and flood events under the present and future conditions with or without climate change	5	Month 30	Month 30	5		CHMI
D35	D5.8 Scenario studies for the assessing responses of the physical and hydrobiological characteristics in the river network and reservoirs to anticipated climate, land use and nutrient source changes in the catchments.	5	Month 30	Month 30	2		IAP
D36	D6.4 International workshop and course for decision makers on the effective use of water in agricultural crop production	6	Month 30	Month 30	6		BOKU
D37	D6.5 Expected changes of occurrence and activity of pests and diseases on selected crops and forest ecosystems	6	Month 30	Month 30	13		IAP
D38	D6.6 Sensitivity analysis of the selected agriculture crops and the most vulnerable forest stands to climate change impacts	6	Month 30	Month 30	26		FRI
D39	D7.3 Key species concentrations files from higher resolution runs (10x10 km) for control run and future projection	7	Month 33	Month 33	46		CUNI
D40	D4.4 Corresponding analyses on the CECILIA high-resolution simulations	4	Month 34	Month 34	43		NMA
D41	D4.5 Sensitivity experiments for feedback processes (land-atmosphere coupling) and their analysis	4	Month 34	Month 34	12		ICTP
D42	D2.6 analysis of scenarios, comparison with ENSEMBLES (2021-2050) and PRUDENCE (2071-2100) responses	2	Month 36	Month 36	51		CNRM
D43	D2.7 report on possible improvements in very high resolution climate simulation	2	Month 36	Month 36	45	6	DMI
D44	D3.6 Comparison with results of ENSEMBLES	3	Month 36	Month 36	8		CUNI
D45	D4.6 Report and/or peer-reviewed papers presenting WP4 studies.	4	Month 36	Month 36	12		ETH

D46	D5.9 Adaptation measures proposed in the reference basins due to the climate change impact	5	Month 36	Month 36	6		NIHWM
D47	D5.10 Local air-sea interaction changes on the western Black Sea coast under different climate conditions, relevance to regional sustainable development.	5	Month 36	Month 36	3		NMA
D48	D6.7 Integrated assessment of climate change and air pollution impacts on C-cycle in agriculture and on forest ecosystems	6	Month 36	Month 36	13		ELU
D49	D6.8 Recommendations and development of management for an improved land use systems in agricultural crop production and forest management under the regional climate change scenarios	6	Month 36	Month 36	19		FRI
D50	D7.4 Analysis and evaluation of the results, comparison of the higher resolution runs (10x10) with the lower resolution runs (50x50) for the specific domain	7	Month 36	Month 36	17		CUNI
D51	D7.5 Present and future key species exceedances of the EU limits and WHO guidelines.	7	Month 36	Month 36	8		WUT
D52	D8.6 Final Plan for using and disseminating knowledge	8	Month 36	Month 36	1		CUNI
D53	D8.7 Report on raising public participation and awareness	8	Month 36	Month 36	1		CUNI
D54	D8.8 Month 36 Final workshop, information and outputs for endusers, policy and decision makers, local authorities etc. (throughout the project period as well)	8	Month 36	Month 36	2		CUNI
D55	D8.9 Final Report	8	Month 38	Month 36	5		CUNI

2.9 List of milestones

Milestone No.	Milestone name	WP number	Date due	Actual/ Forecast delivery date	Lead contractor
M1	M2.1: The integration domains and RCM parameterizations are defined	2	Month 6	Month 6	CNMR
M2	M3.1: datasets prepared, validation criteria formulated, list of variables for impacts agreed	3	Month 6	Month 12	IAP
M3	M4.1: Decision on which measures and indices of extremes should be part of the analyses of WP4 and detailed implementation plan resulting from D4.1	4	Month 6	Month 6	ETH
M4	M6.1: Selection of agricultural and forest regions, Data base on historical data and other model input data, Preparation of the GIS tools	6	Month 6	Month 12	FRI
M5	M1.1: Provision of data from available climate change simulations for first-stream impact work	1	Month 12	Month 12	ICTP
M6	M3.2: SDS methods developed	3	Month 12	Month 12	IAP
M7	M5.1: Calibration of the models using the data over the selected period (1970-2000); Observed data analyses of local air-sea interaction at western Black Sea coast; Calibration and testing of water quality in the modelling system.	5	Month 12	Month 12	NIHWM
M8	M6.2: Calibration and validation process of the selected models (water balance, drought indices and growth) for the main selected crops, crop rotations and forest ecosystems.	6	Month 12	Month 12	FRI
M9	M7.1: Selection of the air-pollution episodes to be simulated from the offline and online chemistry AQMs	7	Month 12	Month 12	AUTH
M10	M1.2: Provision of driving fields from intermediate scale experiments for very fine scale targeted simulations	1	Month 18	Month 18	CNRM
M11	M2.2: The observation driven simulations are ready for other WPs	2	Month 18	Month 18	CUNI
M12	M3.3: RCM output localization methods developed and verified on ERA40 RCM runs	3	Month 18	Month 18	BOKU
M13	M7.2: Simulations of the offline chemistry model CHIMERE and/or CAMx driven by RCM for Europe with 50x50 grid resolution.	7	Month 18	Month 18	AUTH
M14	M2.3: The scenarios and references RCM simulations are ready for other WPs	2	Month 24	Month 24	OMSZ

M15	M2.4: The sensitivity experiments to improved physical parameterizations are analyzed	2	Month 24	Month 24	AUTH
M16	M3.4: validation and comparison of RCM and SDS models completed	3	Month 24	Month 24	IAP
M17	M5.2: Simulation of flow in the case of modified regime; Evaluation of the water demand in present and future conditions; Regional experiment design for air-sea interaction phenomena at western Black Sea coast.	5	Month 24	Month 24	NIHWM
M18	M6.3: Simulated results of the sensitivity of crops and management on crop water use. Results on potential drought damage, water use efficiency and crop water use under the selected climate scenarios. Results about the sensitivity analysis and integrated assessment of the most vulnerable forest stands to climate change and air pollution impacts on forest ecosystems.	6	Month 24	Month 24	BOKU
M19	M7.3: Results from the comparison of key species levels simulated by the offline and online regional AQMs.	7	Month 24	Month 24	WUT
M20	M2.5: The database is ready for access inside the project	2	Month 26	Month 26	DMI
M21	M7.4: Simulations of the offline AQMs driven by RCM for a specific smaller domains in Central Eastern Europe with 10 x 10 grid resolution.	7	Month 28	Month 28	CUNI
M22	M3.5: climate change scenarios for both time slices completed	3	Month 30	Month 30	IAP
M23	M5.3: Assessment of the vulnerability of reference basins and the adaptation measures; Impact study and assessments of climate change in water quality; Assessment of local changes in air-sea interaction modes under different climate conditions and their relevance for regional sustainable development.	5	Month 30	Month 30	NIHWM
M24	M6.4 Month 30: Results on management options for improving effective use of water under climate scenarios in the various agricultural production systems. Results on impacts of climate change on C-cycle in agriculture and forest ecosystems.	6	Month 30	Month 30	IAP
M25	M7.5 Month 30: Results from the analysis of the output of the simulations of the offline chemistry AQMs driven by RCM for Europe with 50x50 grid resolution.	7	Month 30	Month 30	AUTH

M26	M7.6 Month 30: Results from the analysis of the output of the simulations of the offline chemistry AQMs driven by RCM for specific smaller domains in Central Eastern Europe with 10x10 grid resolution.	7	Month 30	Month 30	WUT
M27	M7.7: Results from the calculations of present and future key species exceedances of the EU limits and WHO guidelines for a specific smaller domains in Central Eastern Europe with 10x10 grid resolution	7	Month 30	Month 30	WUT
M28	M2.6: The database is in public access and a report on the gain of high resolution in the local description of climate responses is available	2	Month 36	Month 36	DMI
M29	M3.6: comparison with ENSEMBLES outputs finished	3	Month 36	Month 36	IAP
M30	M4.2:: Finished analyses of extremes based on both pre-existing and CECILIA model output	4	Month 36	Month 36	ETH
M31	M6.5: Final report written and papers submitted. Adaptation analyses, recommendations and development of management options for improved land use systems in agricultural crop production and forest management under the regional climate change scenarios	6	Month 36	Month 36	FRI

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Section 3 Consortium management

The CECILIA project has completed the first year of its activity. Basically, there are no significant delays or problems with some negative consequences for further development. This first year provided the time for preparation of work, namely data necessary for the project as well as the numerous tools, from highly complex climatological models (RCM) to impact models of broad spectrum of complexity. Due to the lack of own simulation generated within the project, for the impact models tests rather different other sources of inputs were used, this is going to be changed soon as having first stream inputs available from WP1 analyses and finally when having the appropriate simulations completed from WP2.

3.1 Consortium management tasks, achievements, problems and how they were solved

3.1.1 Project management tasks

The overall aim of the management of CECILIA is to ensure a smooth running of the project. This was supposed to be achieved through the following objectives:

- application quality management procedures
- application financial management procedures
- maintenance of the documents for the project
- maintenance of on-line information tools of the project
- to ensure appropriate co-operation among the WPs and related projects

The following sub-sections describe the basic ideas of the organization and management of CECILIA. Details were fixed in the Consortium Agreement (CA) signed by all the partners.

3.1.2 Management structure

Management structure of CECILIA has been proposed to cover all possible problems and aspects of the smooth running of the project using maximum of the human resources and - at the same time - minimising the overhead associated with project management in both a general and a technical sense. The organisational hierarchy of the project is outlined in the following:

The Project management has been assured by the following relevant roles: a) Project Manager, b) Workpackage Leaders, c) Team Leaders, and by means of the Scientific Steering Group. Fig. 44 clarifies the relations between the above groups and roles.

The CECILIA co-ordinator, namely CUNI, is responsible for the overall management of the project as specified in the contract with European Commission (EC). For this purpose, the co-ordinator nominated:

a) A **Project Manager (Jiří Mikšovský)**, who is resuming overall responsibility for all the day-to-day project co-ordination matters, assisting and supporting the co-ordinator. The project manager is responsible for:

- monitoring the performance and progress of the project against time and cost plans
- making proposals to amend the plans if unexpected situations arise

- scheduling meetings and distributing minutes
- dissemination and promotion of project activities and results
- maintaining the on-line information tools, web page of the project.

Each partner nominated a **Team Leader (TL)** who is responsible for managing the team within his company. The TL is the official appointee of his institution for management communication and matters with the Coordinator or Project Manager. **WP Leaders (WPL)** represent their WPs in the **Scientific Steering Group** (**SSG**). The SSG will be co-chaired by the Project Coordinator and the Project Manager. The SSC will monitor progress against time and cost and will co-ordinate and control the overall project work and activities. Decisions taken by the SSG are binding for the consortium for the duration of the project. All the decisions of SSG have been unanimous.

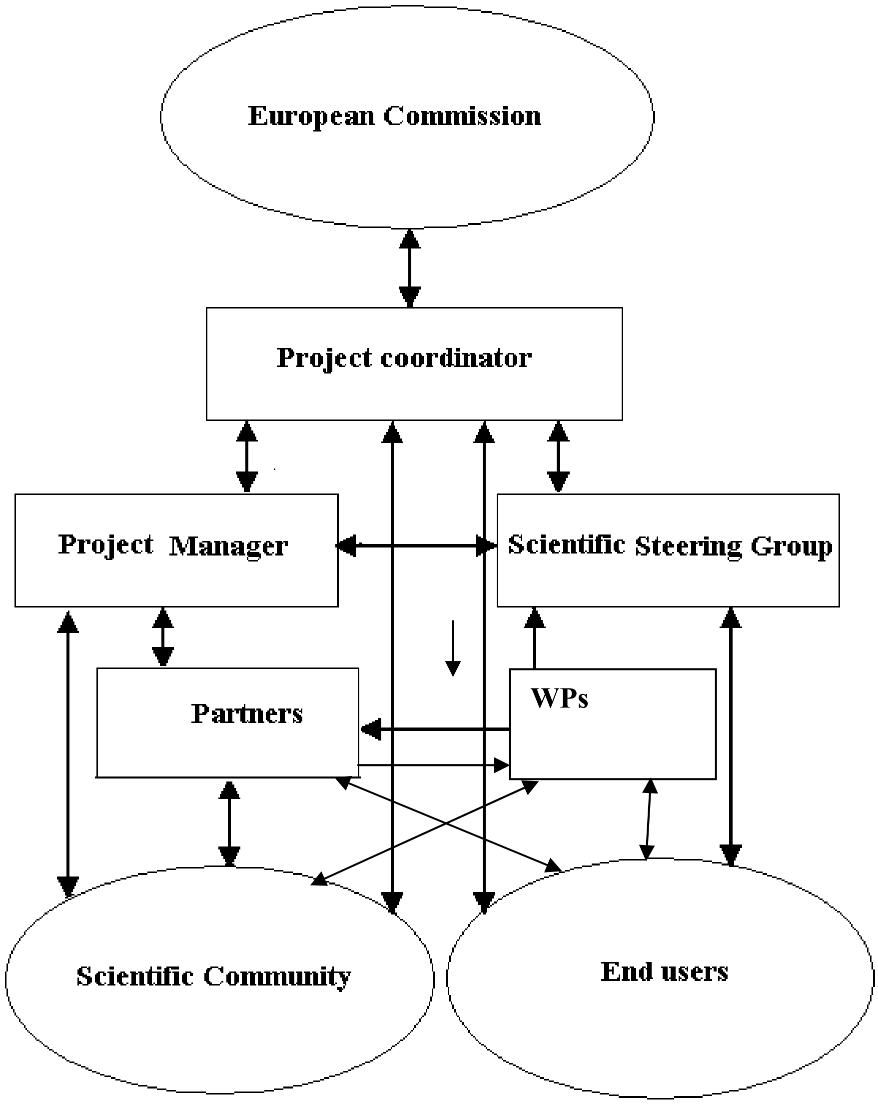

Figure 44: *Management structure*

Workpackage Leaders (WPLs) are responsible for the performance of work packages. Specific tasks for Work package leaders are to ensure accomplishment of the technical objectives of the Workpackage, to report to the Project Manager, to log major decisions related to the progress of the work package, to co-ordinate the issue of deliverables associated with the WP, to flag insufficient quality or unacceptable delays in the contribution of individual members, to co-ordinate the production of external papers in topics dealing with their activities. For each workpackage, the WPL will be appointed by the partner, which is designated as responsible partner for the specific WP.

Workpackage Teams (WPTs) are formed by specialized staff provided by the Partners. Each Workpackage Team is chaired by a WPL, and it is in charge of carrying out the technical work as described in the DoW. Each key deliverable of the project will be reviewed by the SSG.

3.1.3 Coordination of the project, project meetings

Basically, the work continued smoothly and in framework of individual partner's and WP's preparatory work there were not so much tasks in coordination activities from the highest level, all tasks were well defined from DoW. Progress in the work on the project as well as management issues were discussed on Management Meetings held in connection with Project meetings which were supposed to be scheduled at least each 9 months. After kick-off meeting in Month1 further working meetings were held, the first one at the end of Month 8 at Semmering, the second one in Month 13 at Chalkidiki, next meeting being planned for beginning of Month 20 when the first CECILIA simulations driven by ERA 40 should be available from WP2. Towards this some more coordination effort will be necessary, similarly as already done to move the partners to use the first stream data provided by WP1.

As mentioned in the Section 1, there were basically two more important issues which might have implied the problems on the project development. One of them was the difficulty to get the observation data from some territories due to data policy of some Meteorological Services, which produced delay of D3.1 as well as in part of the requirements of M3.1. These problems have made tuning of the tools and mainly their validation which need the use of such data more complicated. The problem was finally solved by the selection of the smaller region for validation and tuning, for which the data will be provided and gridded to the technical series, which are allowed to be shared. Thus, the negative impact to the project has been minimized, individual partners in their territory will further use their own original data knowing the performance of the techniques in framework of the methods used in the whole project. It should be mentioned that this problem has not implied the failure of progress in the appropriate work as a whole, it is rather partial problem, for which at this moment proper corrective action has been already adopted and proposed measures are already under progress.

Another significant problem was not well reported interruption of the duties at FRI by dr. Mindas who was assigned with another duty outside of FRI. The situation was not clarified for a longer time from FRI and the delivery of Deliverable D6.1 was delayed, although work continued following the plans (M6.1). When finally clarified, the substitution was proposed from FRI and after some discussion at SSG meeting in connection to our project meeting at Semmering it was decided to accept the substitution by new FRI leader in a position of WP6 leader, either. The Deliverable D6.1 missing was finally delivered with the delay of 6 months, next D6.2 was delivered about in time. There are no further negative impacts on the project expected from this problem.

3.1.4 Project communication, cooperation with other projects

The communication flow between the partners has been continuous. Extensive use of e-mail was made for the day to day communication between partners of the consortium. A web site (Deliverable D8.1) promoting the CECILIA results and disseminating information about the project was launched in Month 1 of the project lifetime, with links finally from numerous other sites of partners, other projects and activities etc. Closer links with other related projects (ENSEMBLES, CLAVIER, COST 734 - CLIVAGRI, QUANTIFY) were established through an active information exchange process and by attending other projects' meetings by the Project Coordinator, some of these links are based on real cooperation and participation of some partners in these projects. There are some other cooperations, e.g. projects Interreg CADSES Project: “ACCRETe – Agriculture and Climate Changes: how to Reduce human Effects and Threats”, 2005 – 2007 (NMA), Adaptation in European regions at environmental risk under climate change, 2007-2009 (NIMH), Impacts of Climate Change and Variability on European Agriculture, 2006-2009 (NIMH), ADAGIO – Adaptation of agriculture in European Regions at Environmental Risk und Climate Change, 2007-2010 (BOKU), AGRIDEMA - Introducing tools for agricultural decision-making under climate change conditions by connecting users and tool-providers, 2005-2007 (BOKU).

The project provided good opportunity to develop individual partners’ connections necessary for the progress of the project. As the CECLIA effort required e.g. the recalibration of the crop models IAP utilized good personal contacts with the developers of CERES&DSSAT package (Gerrit Hoogenboom-University of Georgia, USA) and with co-developer of the STICs model (Francoise Rugget-INRA Avignon, France). In the field of drought indices IAP brought to CECILIA an outstanding cooperation with National Drought Mitigation Centre, University Nebraska, Lincoln (Prof. Wilhite) who have served as advisors in development of the new versions of Newhall model and in application of drought indices in the Central Europe.

All technical documentation generated by the Project are exchangeable in electronic format, according to a set of guidelines agreed at kick-off meeting and defined in CA. Exchange of information occured mainly by e-mail and file transfer over Internet. A WEB project document repository was made available by the Co-ordinating Partner, there is restricted domain on the Project web pages for these documents, as well as part for downloading and uploading all the project materials. Telephone and fax were used in urgent needs only. Ordinary mail was used for strictly formal correspondence, i.e. when executive signatures were required.

3.1.5 Using and disseminating knowledge

The results of the climate change simulations generated within the CECILIA project are expected to be available for other interested institutes, universities and research centres in Europe. These data will be made available via web access as will be enabled with respect to the size of data files. Some results might be available on CD-ROMs or DVDs. Climate change impact data will be used for further impact research and policy studies and the results of these studies will be available as well. Both the reports and data generated during the project will contribute to the development of the next IPCC assessment report and, of course, the results will be shared and intercompared with other projects (ENSEMBLES, CLAVIER, COST 734, etc.). Spreading the results of the climate change simulations to non-participating institutes and countries of targeted region can significantly increase the efficiency of the project.

There is one important point of the CECILIA dissemination & exploitation strategy, i.e. communication with end-users, stakeholders or policy makers to provide the necessary and reliable information directly as well as having the feedback to the project, especially from end-users for impact studies. This is planned now to be kept throughout the whole project duration instead of the original concept of a single meeting as required for D8.3. The original task following DoW was to hold a single meeting with endusers in the beginning of the project period (Month 6). More efficient way organizing the meeting with endusers whenever having working project meeting in targeted region has been found, however, mainly because of more often occasion for communication of the actual results and feedback and better availability of local endusers at the meetings. I wouldn't be too convenient to bring the endusers from all the target countries or regions to one place for just brief meeting, and there were not so much to offer them at the beginning of the project. By the end of the project, a final workshop will be held to present and disseminate its results, as planned for deliverable D54. Two of the three CECILIA meetings were accompanied by meeting with endusers so far (Bucharest, Romania in June 2006 and Semmering, Austria, in January 2007). The third meeting, which took place in June 2007 in Chalkidiki, Greece, was an exception, since Greece is not one of the areas primarily targeted by the project. As CECILIA continues, other meetings with endusers will be organized (at the moment, four other gatherings are scheduled, all of them in the countries of CE Europe).

The initial meeting with endusers and representatives of governmental offices took place during the CECILIA kick-off meeting in Bucharest. The actual meeting with endusers was organized during the third day of the event, June 14th, 2006. CECILIA was represented by the participants of the scientific part of the meeting, including the project coordinator T. Halenka and heads of individual workpackages. Due to short notice just only two guests from Romanian governmental institutions accepted the invitation to the meeting: A. Nastaseanu (Ministry of Education and Research) and V. Troska (Ministry of Environment). During the time reserved for enduser meeting, presentation of the project, its aims and expected results was provided by T. Halenka. Then the guests introduced themselves and presented their needs and expectations from high resolution climate simulations and impact studies. The event was concluded by discussion with CECILIA participants. Another meeting meeting with potential endusers took place at BOKU premises after the first CECILIA working meeting in January 29-31, 2007 in Semmering, Austria. It lasted about two hours, for CECILIA it was attended by T. Halenka (project coordinator), R. Huth (WP3 leader), S. Seneviratne (WP4 leader), R. Mic (WP5 leader), V. Turcu (WP6 representative) and K. Juda-Rezler (WP7 leader). As BOKU representatives H. Formayer (Inst. of Meteorology, also CECILIA participant) was presented, the meeting was chaired by Mr. Hackl (Austrian Environmental Agency). There were about 50 attendees from 11 institutions participating in the meeting, for more details see D8.3

3.2 Contractors contributions, changes in responsibilities and changes to consortium itself

All the partners are contributing quite actively to the project, they started the work to prepare their data or models for the project purposes upon the starting date despite of the delay of EC funds delivery, although some local problems arised due to this problem with hiring people for working on the project. As most of the partners are involved in AC mode, this gap was replaced by more effort of own staff. Most of the contractors were well established in the appropriate topics already at the beginning of the project and in further closer cooperation in framework of WP teams significant progress has been achieved.

A significant problem happened with not well reported interruption of the duties at FRI by dr. Mindas who was assigned with another duty outside of FRI. The situation was not clarified for a longer time from FRI and the delivery of Deliverable D6.1 was delayed, although work continued following the plans (M6.1). When finally clarified, the substitution was proposed from FRI and after some discussion at SSG meeting in connection to our project meeting at Semmering it was decided to accept the substitution by new FRI leader dr. Hlasny in a position of WP6 leader, either. Further development of the situation and the performance of the new WP6 leader looks very well, the Deliverable D6.1 missing was finally delivered with the delay of 6 months, next D6.2 was delivered about in time. There are no further negative impacts on the project expected from this problem.

There are another changes of responsibilities in two partners institutions. At ETH S. Seneviratne has been appointed to the role of team leader instead of C. Schär, similarly, M. Lakatos at OMSZ has took the responsibility for the project instead of S. Kertesz. All these changes were submitted as proposal for amendment to the Contract to EC together with another formal small change of name of IAP.

Moreover, one significant proposal for amendment of the Contract submitted was dealing with adding of the new partner. National Center for Scientific and Applied Preventive Medicine (CNSPMP), Moldova, expressed the interest to get closer to CECILIA project using our simulations for impact studies in Moldova, especially for health effects, as well as for validation of the simulations and climate change scenario construction for their territory. As the territory of Moldova is reasonably covered by NMA integration domain and we are interested to spread our impact applications and validation regions as well, SSG proposed and GA approved by voting unanimously on 31 January 2007 the resolution which supposes the Coordinator starting the work on CNSPMP affiliation. It was discussed with the Project Officer and option to get them aboard officially as a partner seems to be more convenient to guarantee proper relations with respect to the data and know-how sharing. Moreover, for the project it can serve as a testbed of connection with endusers. It was agreed with CNSPMP that they will join the project using their local fundings, without any funding from CECILIA except if necessary travel costs to the CECILIA meetings might be reimbursed from management funds of the Coordinator.

3.3 Project timetable and status

The CECILIA project has completed the first year of its activity now. There are only a few minor deviations with respect to project timetable with one significant delay in WP3 mentioned above where already the decision to fix the problem has been adopted as well as delay in WP6, where corrective measure were successfully adopted and no further negative consequences are expected. It should not be the case of the delay in WP3, either, since now the delay is only due the capacity of computation of technical series for finally selected domain, there is no principal problem there.

The present status of the project as well as planned tasks are presented in Tab. 11. There is no reason to modify it except one comment concerning the planning of scenarios simulations with both deliverable D2.4 and milestone M2.3 due Month 24. As can be seen from the barchart (the same in DoW), actually these are three tasks, one for control and another two for scenario runs with planned time of Month 21, 24 and 27, respectively, which still provides enough time for completing of impact runs for the end of century time slice. Thus, some flexibility might be allowed in delivering these results. With respect to their volumes, it will be even necessary to organize the transfer of the primary results step by step.

Table 11: *Frontlined barchart of the CECILIA project status and timetable*

PROJECT BARCHART and STATUS

Acronym CECILIA
Contract No. 037005

12M report | 24M report | 36M report

YEAR 1 (months 1–12) | YEAR 2 (months 13–24) | YEAR 3 (months 25–36)

WP 1	
Task 1.1	Summary of scenarios available for Central and Eastern Europe
Task 1.2	Finishing ARPEGE Climate simulation 2051-2100 not available from ENSEMBLES
Task 1.3	Summary of impacts studies for CEE from ENSEMBLES
WP2	
Task 2.1	High resolution parameterization tests, new parameterization implementation
Task 2.2	Sensitivity to model domain choice
Task 2.3	ERA40 runs
Task 2.4	Present time slice 1970-2000
Task 2.5	Near future time slice 2020-2050
Task 2.6	Century time slice 2070-2100
Task 2.7	Comparison the results with ENSEMBLES, summary
WP3	
Task 3.1	Data preparation, formulation of validation criteria
Task 3.2	RCM output localization methods: development, application to ERA 40 RCM runs
Task 3.3	Development of SDS methods
Task 3.4	Validation of RCM and SDS models
Task 3.5	Production of climate change scenarios
Task 3.6	Comparison of results with ENSEMBLES, summary
WP4	
Task 4.1	Definitions of indicies, selection of variables
Task 4.2	Analysis of available observational datasets
Task 4.3	Analysis of selection of pre-existing RCM data sets
Task 4.4	Analyses of the CECILIA driving-model simulations
Task 4.5	Analyses on the CECILIA high-resolution simulations
Task 4.6	Comparison, summary
WP5	
Task 5.1	Hydrological models preparation for high resolution inputs
Task 5.2	Tests of the models for present climate
Task 5.3	Climate change impact study, vulnerability assesment
WP6	
Task 6.1	Crop and forest models, preparation for high resolution
Task 6.2	Tests of the models for present climate
Task 6.3	Climate change impact study, vulnerability assesment
WP7	
Task 7.1	CTM-RCM couple preparation, chemistry parameterization
Task 7.2	Assesment of the model system behaviour for present climate
Task 7.3	Climate change impact study, vulnerability assesment
WP8	
Task 8.1	Management
Task 8.2	Report 1
Task 8.3	Report 2
Task 8.4	Report 3

Annex – Plan for using and disseminating the knowledge

Section 1 - Exploitable knowledge and its Use

The results obtained do not contain explicitly exploitable knowledge and thus there is no direct commercial application.

Section 2 – Dissemination of knowledge

The dissemination activities section should include past and future activities and will normally be in the form of a table maintained by the coordinator or any other person charged with controlling the dissemination activities**.**

Overview table

	Date	Type	Type of audience	Size of audience	Countries addressed	Partner involved
1	1/19/2007	Other	General public		Any	CUNI
2	N/A	Journal	--		Hungary	ELU
3	2/7/2007	Oral presentation	Higher education	100	Hungary	ELU
4	11/24/2006	Oral presentation	Research	80	Hungary	ELU
5	N/A	Journal	Research		Poland, Czech Republic, Slovakia, Hungary, Romania, Bulgaria	ETH Zurich
6	N/A	Proceedings	Research		Hungary, Slovakia, Romania, Austria, Czech Republic	ELU
7	9/11/2006	Proceedings	Research		Hungary, Slovakia, Czech Republic	ELU
8	9/11/2006	Proceedings	Research		Hungary, Slovakia, Czech Republic	ELU
9	1/14/2007	Proceedings	Research		Hungary	ELU
10	N/A	Oral presentation	Research	25	NO, SE, FI, DK, UK, RU, US	IAP
11	9/6/2006	Proceedings	Research		Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
12	9/6/2006	Proceedings	Research		Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
13	9/6/2006	Oral presentation	Research		Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
14	11/30/2006	Proceedings	Research		Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
15	11/30/2006	Proceedings	Research		Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
16	10/20/2006	Oral presentation	Research	100	Hungary	ELU
17	9/22/2006	Oral presentation	General public	80	Hungary	ELU
18	8/21/2006	Oral presentation	Research	100	Hungary, Slovakia, Austria, Romania, Serbia, Croatia, Ukraine	ELU
19	9/4/2006	Oral presentation	Research	100	Hungary, Slovakia, Austria, Romania	ELU
20	6/24/2006	Poster	Research	80	Hungary	ELU
21	9/4/2006	Poster	Research	200	Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
22	1/14/2007	Poster	Research	500	Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
23	4/15/2007	Poster	Research	3000	Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
24	4/15/2007	Poster	Research	3000	Hungary, Slovakia, Austria, Romania, Serbia, Croatia	ELU
25	5/10/2007	Oral presentation	General public	500	Hungary	ELU
26	9/3/2006	Poster	--		Hungary	Hungary

27	5/29/2006	Oral presentation	--		Hungary	Hungary
28	2/3/2006	Proceedings	--		Hungary	Hungary
29	4/20/2007	Oral presentation	--		Hungary	Hungary
30	5/29/2007	Oral presentation	Research		Eastern Europe	ETH
31	2/18/2007	Oral presentation	Research		Eastern Europe	ETH
32	1/18/2007	Oral presentation	Higher education		Eastern Europe	ETH
33	4/19/2007	Oral presentation	Research		Eastern Europe	ETH
34	4/17/2007	Poster	Research		Eastern Europe	ETH
35	6/1/2006	Oral presentation	Research	137	world	CUNI
36	6/14/2006	Oral presentation	Research	25	Romania, Europe	CUNI
37	4/20/2007	Oral presentation	Higher education	15	Poland	WUT
38	6/5/2007	Oral presentation	General public	50	Europe	WUT
39	2/14/2007	Oral presentation	Research	30	Poland, Central and Eastern Europe	WUT
40	9/20/2006	Oral presentation	Research		Romania	HIHWM
41	10/7/2007	Oral presentation	Research		Romania	MIHWM
42	7/17/2006	Poster	Research	200	Conference WMO Living with the climate, Helsinki	CUNI
43	9/4/2006	Oral presentation	Research	100	EMS Annual Meeting, Europe	CUNI
44	9/15/2006	Oral presentation	Research	25	ENSEMBLES Training Workshop, Europe	CUNI
45	10/3/2006	Poster	Research	40	ENSEMBLES RT7/RT8 Workshop on Adaptation to Climatic Change in the European Alps, Wengen, 4-6/10/06	CUNI
46	11/17/2006	Oral presentation	Research	30	COST 734 kick-off meeting, Brussels, 15-17/11/06	CUNI
47	11/21/2006	Oral presentation	Research	100	ENSEMBLES GA 2006, Lund, Europe	CUNI
48	5/15/2007	Oral presentation	Research	20	Seminar of CMeS, Prague, Czech Republic	CUNI
49	1/31/2007	Media	--	50	CECILIA Press Release for end-users workshop	CUNI
50	12/01/2006	Oral presentation	Research	30	CLAVIER kick-off meeting, Budapest,	CUNI
51	03/13/2007	Oral presentation	Research	30	Europe-Japan Workshop, Brussels, 12-13/03/07	CUNI
52	03/19/2007	Poster	Research	200	WMO International Conference on Secure and Sustainable Living, Madrid, 19-22/03/07	CUNI
53	03/27/2007	Oral presentation	Research	50	6th International Conference on Urban Air Quality, Cyprus, 26-29/03/07	CUNI
54	04/19/2007	Poster	Research	200	EGU 2007, Vienna, 16-20/04/07	CUNI
55	04/18/2007	Poster	Research	200	EGU 2007, Vienna, 16-20/04/07	CUNI
56	04/25/2007	Oral presentation	Research	70	Conference Air 2007, Brno, Czech Republic, 23-25/04/07	CUNI

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Section 3 - Publishable results

There are no exploitable results.