SIXTH FRAMEWORK PROGRAMME

SUB-PRIORITY 1.1.6.3

Global Change and Ecosystems

Contract for:

SPECIFIC TARGETED RESEARCH PROJECT

Annex I - "Description of Work"

Project acronym: **CECILIA**
Project full title: **Central and Eastern Europe Climate Change Impact and VulnerabiLIty Assessment**
Priority thematic areas: 1.1.6.3.I.3.2 - Climate change impacts in central-eastern Europe
Proposal/Contract no.: **037005**
Related to other Contract no.: *(to be completed by Commission)*
Date of preparation of Annex I: **20 February 2006, modified 20 November 2008**
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Content:

1 Project summary

The main objective of CECILIA is to deliver a climate change impacts and vulnerability assessment in targeted areas of Central and Eastern Europe. Emphasis is given to applications of regional climate modelling studies at a resolution of 10 km for local impact studies in key sectors of the region. The project contains studies of hydrology, water quality, and water management (focusing at medium-sized river catchments and the Black Sea coast), air quality issues in urban areas (Black Triangle – a polluted region around the common borders of the Czech Republic, Poland and Germany), agriculture (crop yield, pests and diseases, carbon cycle), and forestry (management, carbon cycle). Very high resolution simulations over this region are necessary due to the presence of complex topographical and land use features. Climate change impacts on large urban and industrial areas modulated by topographical and land-use effects which can be resolved at the 10 km scale, are investigated by CECILIA. The high spatial and temporal resolution of dense national observational networks at high temporal resolution and of the CECILIA regional model experiments will uniquely feed into investigations of climate change consequences for weather extremes in the region under study. Comparison with the results based on statistical downscaling techniques 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.

2 Project objective(s)

2.1 Introduction

After the political changes that occurred in countries of the former Eastern Block at the end of 80's, climate change started to be taken into account to some extent at the governmental level. In particular, from the scientific point of view, at the beginning of 90's the access to information and data started to become a reality. Around the mid 90's significant improvements in cooperation were promoted by the US Country Study Programme. Under this framework, many countries from the former Eastern Block obtained access to global climate-change scenarios and longer series of global climatological data. They participated to workshops on the use of this information for the assessment of climate-change impacts on agriculture, forestry, water management and health. Unfortunately, at that time there was very limited equipment to handle large amount of data and, moreover, not sufficient know-how in this region to start real cooperation efforts in the field of climate-change modelling. However, this knowledge gap has been progressively eliminated and when the regional climate model RegCM appeared through ICTP in several countries of Central and Eastern Europe at the end of 90's, it proved the feasibility of carrying out regional climate-change studies performed by local users in this area. Eventually the adaptation of a commonly used NWP model in LACE countries, i.e. the model ALADIN from Météo-France, started in 2001 in Czech Republic and now this model, ALADIN-Climate, has taken part in the EC FP6 project ENSEMBLES. Thus, the door has been opened for real climate change impact and vulnerability assessments for central and eastern Europe based on locally provided high resolution regional climate modelling.

During the last decade regional climate models (RCMs) have been increasingly used to examine climate variations at scales that are not resolved by global models. To the extent that they produce realistic climate simulations, such models can be powerful tools in the study of regional climate impacts. Since the field of regional climate prediction is still evolving, the skill of RCMs in simulating climate variability has not been extensively evaluated. This is planned within the framework of the project ENSEMBLES for simulations of 50 to 25 km resolution driven by ERA40 reanalyses. As part of the ENSEMBLES project transient scenario runs of 100 – 150 year's length are also planned under different greenhouse gases (GHG) and aerosol forcing. In this proposal we plan a detailed analysis and use of the results of the project ENSEMBLES for focused initial impact studies in our target region. However, one of the main objectives of this proposal is also 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, which will provide additional information related to the complex terrain of the region. 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 and size of the model domain. Moreover, 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 will provide a connection with the EC FP6 Project QUANTIFY, which aims at quantifying the impact of transportation on climate change. Our project will also provide insights on the validation and relative merits of statistical and dynamical downscaling, in particular as applied to provide local climate information.

2.2 Main goal

The main goal of the proposal is to integrate results from different previous and ongoing modelling activities and approaches to provide the basis for very high resolution climate change impact and vulnerability assessment in important human activity sectors and natural ecosystems. It is prohibitive to cover within the STREP all the sectors in their complexity, so that we target our analysis on some key areas of specific interest to the region. For example, the flood and drought conditions which occurred in recent summers over the region highlight the importance of the hydrologic cycle and water management in the Elbe and Danube river catchments in response to changes in the occurrence of precipitation extremes. Impacts on agriculture and forestry influencing the economy of countries in the region will be studied with emphasis on the main productions in the area. The 2003 heat wave demonstrated the importance of studies of the health impacts of extreme conditions that would also lead to considerable changes in air quality, both regionally and in major urban centres.

The proposed research will benefit greatly from previous and ongoing European projects and programmes with related objectives, 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)

2.3 Aims and objectives

The overall aim of this proposal is to assess the impact of climate change at the regional to local scale for the territory of central and eastern Europe, with emphasis on using very high climate resolution in order to capture the effects of the complex terrain of the region. From the viewpoint of climate scenario production, this goal will be achieved through a strategy of multiple and combined approaches, namely variable resolution models, RCMs and statistical downscaling methodologies. The primary tools, however, will be very high resolution RCMs run locally for targeted areas. From the impact viewpoint, the most important sectors for the economies and welfare of individual countries will be selected. These objectives will be achieved through the execution of the following specific tasks:

- To collect, assess and make available for first local impact studies the scenarios and climate simulations produced in previous relevant projects, especially PRUDENCE, STARTDEX, MICE and ENSEMBLES, where available. (WP1, D1.1-D1.4)
- To adapt and develop very high resolution RCMs for the region (10 km grid spacing) and perform regional time-slice nested simulations driven by ERA40 data and by GCMs for selected GHG change scenarios. (WP2, D2.1-D2.7)
- To verify the model results, compare RCM and statistical downscaling results, analyze and develop the methods for verification, particularly at local scales. (WP3, D3.1-D3.6)
- To estimate the effect of global climate change on the occurrence of extreme events (heavy precipitation, heat waves, droughts) in the region, including the assessment of the added value of high-resolution experiments for the simulation of the relevant processes and feedbacks. (WP4, D4.1, D4.4,D4.5)
- To evaluate uncertainties in regional climate change projections by intercomparing results obtained in previous projects (PRUDENCE, ENSEMBLES) and the present ones. (WP4, D4.2, D4.3)
- To assess (based on the high resolution downscaling results) the impacts of climate change on the hydrological cycle and water resources over selected catchments in the region; to study the effects of climate change on the Black Sea (WP5, D5.1-D5.10)
- To study (based on the high resolution downscaling results) the impacts of climate change on agriculture and forestry, carbon cycle and selected species (WP6, D6.1-D6.8)
- 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, D7.1-D7.5)

3 Participant list

The consortium comprises 16 partner institutions that bring together a wide range of inter-disciplinary expertise and experience in the areas of climate change modelling, statistical analysis, climate change impact assessment as well as anthropogenic and biogenic pollutant emissions. Reflecting the shared and overlapping expertise and interests of the partners, most of the work packages involve contributions from several participants, under the direction of a lead partner. This arrangement brings benefits, not only in ensuring close linkages between all the parts of the project, but also in stimulating critical debate and exchange of expertise, and in providing back-up in the event of unforeseen difficulties. As the targeted area is central and eastern Europe the substantial part of participant institutes comes from this area (10-12, depending on the political or geographical point of view), complemented by selected partners from western part of EU to add necessary access to experience, know how and data for working on the project.

All the partners are governmental organizations, i.e. public. There is no SME between the partners, it was not addressed as this kind of research is provided in the big national institutes, research centres and at main universities in this area. Some end users could come from this type of organization.

List of Participants

Partic. Role	Partic. No.	Participant name	Participant short name	Country	Date enter project	Date exit project
CO	1	Charles University, Prague	CUNI	Czech Rep.	month 1	month 43
CR	2	The Abdus Salam ICTP, Trieste	ICTP	Italy	month 1	month 43
CR	3	Météo-France, Toulouse	CNRM	France	month 1	month 43
CR	4	Danish Meteorological Institute, Copenhagen	DMI	Denmark	month 1	month 43
CR	5	Aristotle University of Thessaloniki	AUTH	Greece	month 1	month 43
CR	6	Czech Hydrometeorological Institute, Prague	CHMI	Czech Rep.	month 1	month 43
CR	7	Institute of Atmospheric Physics, Prague	IAP	Czech Rep.	month 1	month 43
CR	8	Swiss Federal Institute of Technology Zurich	ETH	Switzerland	month 1	month 43
CR	9	University of Natural Resources and Applied Life Sciences, Vienna	BOKU	Austria	month 1	month 43
CR	10	National Meteorological Administration, Bucharest	NMA	Romania	month 1	month 43
CR	11	National Institute of Meteorology and Hydrology, Sofia	NIMH	Bulgaria	month 1	month 43
CR	12	National Institute of Hydrology and Water Management, Bucharest	NIHWM	Romania	month 1	month 43
CR	13	Hungarian Meteorological Service, Budapest	OMSZ	Hungary	month 1	month 43
CR	14	Forest Research Institute, Zvolen	FRI	Slovakia	month 1	month 43
CR	15	Warsaw University of Technology, Warsaw	WUT	Poland	month 1	month 43
CR	17	Eötvös Loránd University, Budapest	ELU	Hungary	month 1	month 43
CR	18	National Center for Scientific and Applied Preventive Medicine, Chisinau	CNSPMP	Republic of Moldova	month 16	month 43

4 Relevance to the objectives of the specific programme and/or thematic priority

The CECILIA proposal addresses directly and to the maximum extent enabled by the instrument prescribed the call for Specific Targeted Research Projects in the topic I.3.2 “Climate changes in central-eastern Europe” under reaearch 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 proposed objectives, work plan and deliverables contribute directly to meeting the scientific, technical and social and policy objectives of this topic area, as indicated in the section below.

The text of the call for the topic addressed reads: “*Quantification (based on appropriate regional modelling and downscaling approaches) of specific climate change impacts in central-eastern Europe. Probable changes over the next decades to a century should be considered, including changes in weather patterns, extreme events, water resources, and associated consequences on e.g. agriculture, forestry and air pollution levels.*” The overall aim of this proposal is to assess the impact of climate change at the regional to local scale for the territory of central and eastern Europe with emphasis on using very high climate resolution in order to capture the effects of the complex terrain of the region. This goal will be achieved through a strategy of multiple and combined approaches, mainly using regional climate modelling and statistical downscaling methodologies. The primary tools, however, will be very high resolution RCMs run locally for targeted areas. From the viewpoint of climate change scenario production two time slices are planned, next decades simulation (2020-2050) and end of century simulation (2070-2100). Following the objectives presented in B.1.2, changes in weather patterns and extreme events are addressed within this proposal as they affect the most important sectors for the economies and welfare of individual countries in the region. The flood and drought conditions which occurred in recent summers over the region highlight the importance of the hydrologic cycle and water management in the Elbe and Danube river catchements in response to changes in the occurrence of precipitation extremes. The 2003 heat wave demonstrated the importance of studies of the health impacts of extreme conditions that would also lead to considerable changes in air quality, both regionally and in major urban centres. Impacts on agriculture and forestry influencing the economy of countries in the region will be studied with emphasis on the main productions in the area.

With these objectives the CECILIA proposal supports well the general ideas of the area 3.1 “Impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks” area. Model systems used in project ENSEMBLES project will be used here to describe the impact of greenhouse gas emissions and atmospheric pollutants on climate change processes, and the local effects of climate change on pollutants an related health impacts. Therefore, the proposal CECILIA meets the objectives of the call in sub-area 3.1.3. “Prediction of climatic change and its impacts”. Uncertainties in climate changes and associated impacts will be evaluated by comparing results with those from previous projects (PRUDENCE, ENSEMBLES). The exploitation of the results will be maximised by linking the CECILIA outputs to selected applications, including water resources and water management, agriculture, forestry, air quality and health. In addition, CECILIA will improve the access of central and eastern European researchers to information and facilities for climate change research by providing an efficient use and access to the results of previous EC projects.

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 appropriate adaptation and mitigation response strategies in targeted areas.

4.1 Regional climate modelling

Global Circulation Models (GCMs) can reproduce reasonably well climate features on large scales (global and continental), but their accuracy decreases when proceeding from continental to regional and local scales because of the lack of resolution (Gates et al., 1996). This is especially true for surface fields, such as precipitation and surface air temperature, which are critically affected by topography and land use. However, in many applications, particularly related to the assessment of climate-change impacts, the information on surface climate change at regional to local scale is fundamental. To bridge the gap between the climate information provided by GCMs and that needed in impact studies, several approaches have been developed, commonly called downscaling or regionalization techniques (Giorgi and Mearns, 1991; Giorgi et al. 2001). The most popular approaches are (i) statistical downscaling, i.e., identification of statistical relationships between large-scale fields and local surface climate elements, and (ii) dynamical downscaling, i.e., nesting of a fine scale limited area model (or Regional Climate Model, RCM) within the GCM. The latter approach is more correct from a physical point of view, but is much more demanding on computer resources. Comparisons of statistical and dynamical downscaling indicate a similar skill of the two methods in simulating present day climate, but often quite different in simulations of the regional climate change signal (Kidson and Thompson, 1998; Murphy, 1999; Mearns et al. 1999; Busuioc et al. 2005). Another way to increase resolution is to use GCM with a variable horizontal resolution (Déqué and Piedelievre, 1995; Déqué et al., 1998), an approach that however requires even larger computational resources than RCMs. The availability of different methodologies giving often different results implies that a full assessment of the uncertainties in regional climate change simulation may require the use of multiple techniques (as proposed in this project).

In the region of central and eastern Europe the need for high resolution studies is particularly important. This region is characterized by the northern flanks of the Alps, the long arc of the Carpathians, and smaller mountain chains and highlands in the Czech Republic, Slovakia, Romania and Bulgaria 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. 1, where comparison of topography representation for ENSEMBLES resolutions 50 and 25 km to proposed CECILIA resolution of 10 km is presented in the detailed view on the Czech Republic.

One of the commonly used RCM in the targeted regions is the model RegCM distributed freely from ICTP. The model was originally developed by Giorgi et al. (1993a,b) and then has undergone a number of improvements described in Giorgi et al. (1999), Pal et al. (2000) and, finally, Pal et al. (2005). The dynamical core of the RegCM is equivalent to the hydrostatic version of the NCAR/Pennsylvania State University 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.

Another RCM has been used recently, starting from an operational NWP model used in several national meteorological services in the targeted domain. This is the ALADIN-CLIMATE model and first experiences from its development can be found in Huth et al. (2003). Originally, the limited-area prediction model ALADIN has been developed by the international team headed by Météo-France and modification for RCM purposes started in 2001 in cooperation with CHMI in Prague. ALADIN is a fully three-dimensional baroclinic system of primitive equations using a two-time-level semi-Lagrangian semi-implicit numerical integration scheme and digital filter initialisation.

For the description of the model and its parameterizations, refer e.g. to Bubnová et al. (1994) and Váňa (1998). The physical parameterizations package comprises gravity wave drag parameterization, implicit horizontal diffusion computed in spectral space (fourth order and increasing with height), vertical diffusion and planetary boundary layer parameterization, constant analyzed sea surface temperature and amount of sea-ice, an improved version of the ISBA (Interaction Soil Biosphere Atmosphere) scheme, including an explicit parameterization of soil freezing (prognostic variables in ISBA: surface temperature, mean soil temperature, interception water content, superficial soil water content, total liquid soil water content, total frozen soil water content), simple parameterization of snow cover, soil characteristics (texture, depth) that are point-dependent, vegetation characteristics that are point- and month-dependent, simplified radiation scheme called at every time step, mass flux convection scheme including the entrainment profile, specific humidity as a solely prognostic variable: no storage of condensate; evaporation of falling rain; treatment of the ice-phase, and a sophisticated diagnostic cloud (and cloud content) method used for radiative transfer calculations. For running the ALADIN model in a climate mode, a few modifications had to be made, which include mainly changes in lower boundary condition specifications and availability of restart.

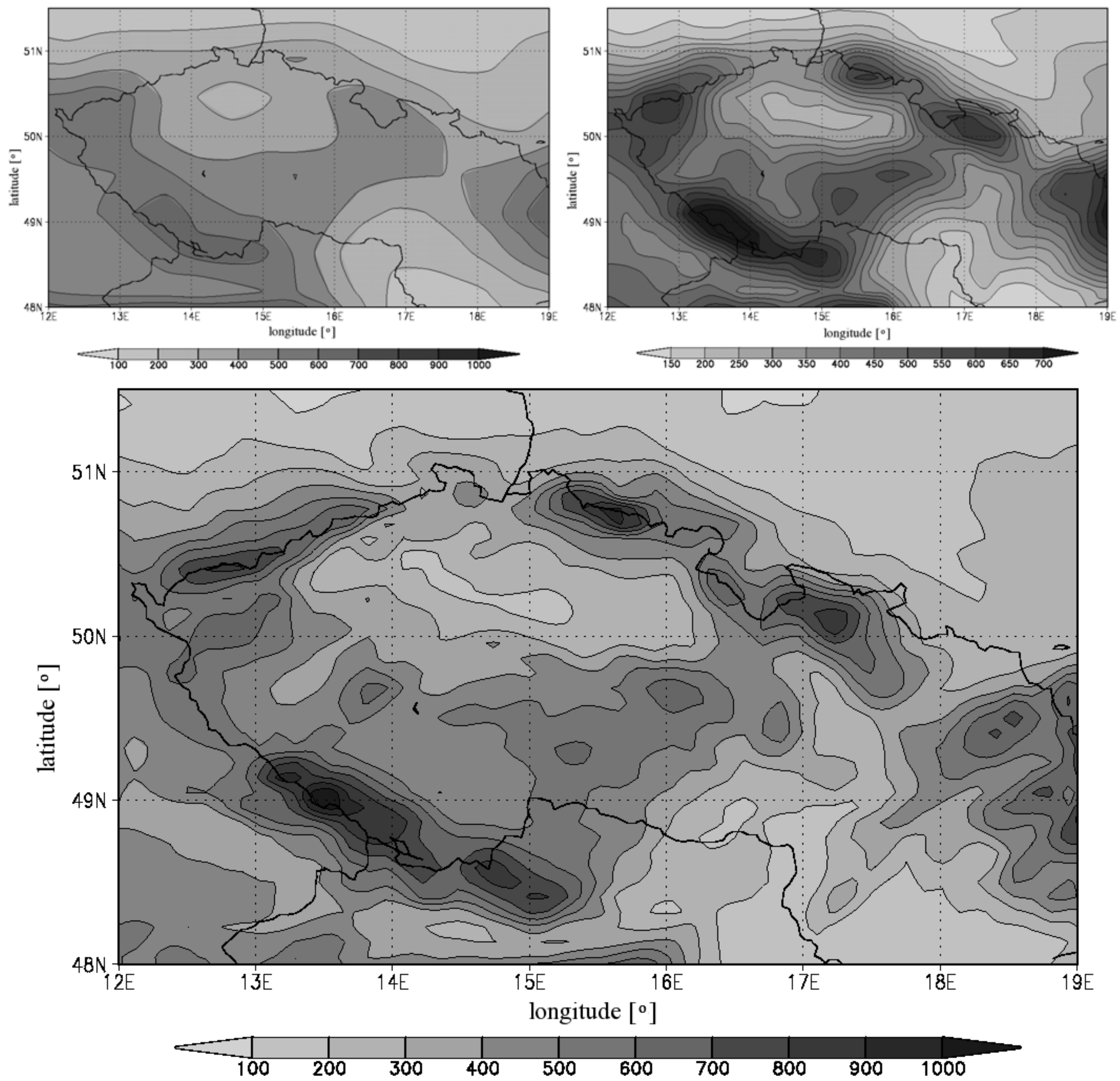

Figure 1. *Detail of topographical features seen in ENSEMBLES' 50 km resolution (upper left) and 25 km (upper right) and 10 km for CECILIA proposal (bottom panel).*

4.2 Statistical downscaling, model validation and climate change scenarios preparation

Statistical downscaling (SDS) is an alternative approach to dynamical downscaling, i.e., regional climate modelling (e.g., Giorgi et al. 2001). The few studies having compared the two approaches indicate they operate with a comparable performance (Kidson and Thompson 1998; Murphy 1999; Wilby et al. 2000; Oshima et al. 2002; Busuioc et al. 2005). The advantages of SDS models consist, among others, in their rather modest computer requirements and portability. SDS essentially consists of seeking statistical relationships between the variables simulated well by GCMs (predictors) and the surface climate variables of interest (predictands). These relationships are usually trained on observed data (frequently represented by reanalyses), and then applied to the control and perturbed GCM outputs, the former serving for verification and the latter for climate change scenario construction. For a SDS method to be applied correctly, several assumptions must be met; the most important ones being the stationarity of the predictor-predictand relationship, the capacity of the driving GCM to simulate the predictor, and large enough variance of the predictand being explained by the predictor. The verification of these assumptions must be an integral part of any downscaling study. As for the methods, the majority of SDS studies employ linear methods, most notably multiple linear regression (MLR) and canonical correlation analysis (CCA). Nonlinear methods have recently begun to emerge, being represented mainly by artificial neural networks (ANNs) (e.g., Crane and Hewitson 1998; Wilby et al. 1998; Weichert and Bürger 1998; Cavazos 2000; Mpelasoka et al. 2001; Schoof and Pryor 2001). Other nonlinear techniques include local models in reconstructed phase space (Mikšovský and Raidl 2005). An additional option is touse simple analogues methods, which sometimes can outperform several more complex approaches (Zorita and von Storch 1999).

RCMs even at very high resolutions of less than 20 km do not provide site-specific information which is required in many impact models. The discrepancy between the local scale required in impact studies and the regional scale provided by RCMs becomes relevant especially in regions with complex topographical features, which are typical of the focal area of this project. Examples of such areas include mountains (e.g., the Alps, Carpathians), complex coast lines (e.g., Greece), and lake-rich areas (parts of Poland). Therefore, it appears necessary to locally downscale also the RCM outputs over the target sites. Methods for localization of climate model outputs have recently been proposed and developed for the extremely complex area of Scandinavia by Benestad (2004, 2005). They are based on regression against geographical variables, such as latitude, longitude, altitude, slope, distance from the coastline, with the regression residuals being interpolated using geostatistical methods. An alternative procedure is to use a MOS-like approach, using the variables simulated by a model (here, by a RCM) as predictors (Widmann et al. 2003).

In most studies, simulated time series are verified against observations in terms of distance measures such as root-mean-square error and correlation coefficient, and in terms of the first two statistical moments, i.e., mean and standard deviation. To verify the correspondence of patterns in terms of standard statistical measures (correlation, standard deviation, rms difference), Taylor diagrams are employed (Taylor 2001). These are, however, only a few of possible criteria. In various impact sectors, other criteria may appear relevant; e.g. accuracy of the time structure in crop growth modelling, and of spatial structure in hydrological modelling. In spite of it, not much has so far been done in such an enhanced validation of climate models. The few studies employing a more complex validation strategies include autocorrelations (Buishand and Beersma 1993; Mearns et al. 1995; Kalvová and Nemešová 1998; Huth et al. 2001), the occurrence of prolonged extreme events, such as heat / cold waves and dry / wet spells (Trigo and Palutikof 1999; Huth et al. 2000, 2001; Busuioc and von Storch 2003), higher-order statistical moments (Huth et al. 2003), spatial structure (Solman and Nuñez 1999; Easterling 1999; Huth 2002), trends and reproduction of contrasting climatic states (von Storch 1993; Busuioc et al. 2001, 2005; Lucarini and Russell 2002; Braganza et al. 2004; Giorgi et al. 2004), and relationships among variables (Groisman et al. 2000; Murphy 2000; Wilby and Wigley 2000), including connections between the spatial patterns of predictors and predictands (Busuioc et al. 2001, 2005). Climate change estimates based on SDS methods have been shown to be sensitive to methodological options and choices; therefore, in order that the climate change scenarios derived by SDS method be sound, the validation based on recent trends is extremely important (Busuioc et al. 2001; Huth 2004).

High-resolution (both in space and time) weather data representing present and changed climate conditions are required in climate change impact studies. The set of weather variables and their spatial and temporal resolution may differ for various systems studied. For example, the crop growth models used in estimating impacts of climate change and climate variability on crop production (Semenov and Porter 1995, Mearns et al. 1997, Žalud and Dubrovský 2002) typically require single site daily series of extreme temperatures, precipitation and solar radiation. The WOFOST crop growth model (Supit et al. 1994) also requires humidity and wind speed. On the other hand, the hydrological models, which simulate the runoff regimes over larger areas often require weather data from more sites.

Climate change scenarios represent differences (or ratios) in individual climatic characteristics between the future climate and the current (control) climate, usually as simulated by a climate model (Houghton et al. 2001), which is commonly a GCM but may also be a RCM (Mearns et al. 1997; Giorgi et al. 2004). Alternatively, pattern-scaling techniques can be used (Santer et al. 1990; Dubrovský et al. 2005): the standardised scenario, which relates responses of climatic characteristics to the 1 ºC rise in the global mean temperature, is multiplied by the prognosed change in the global mean temperature (ΔTG). The standardised scenarios are determined from the simulated time series using regression techniques. Changes in ΔTG for selected emission scenarios and climate sensitivities may be estimated by other means than GCM, e.g. by simple climate models (MAGICC, Harvey et al. 1997; Hulme et al. 2000).

From the climate change scenario, two techniques are typically used to construct the weather series representing the changed climate (Dubrovský et al. 2000): (i) observed weather series are modified (additively or multiplicatively) by the scenario parameters (e.g. Maytín et al. 1995; Mearns et al. 1992), (ii) weather series are produced by weather generators whose parameters were modified according to the scenario (e.g. Dubrovský et al. 2000; Riha et al. 1996; Semenov and Barrow 1997). Alternatively, direct outputs from SDS models may be used.

The GCM based climate change scenarios are characterized by many uncertainties (Houghton et al. 2001, chapter 13.5), which contribute to the overall uncertainty by various amounts. Giorgi and Francisco (2000) compared various sources of uncertainties and found that the dominant source of uncertainty in the simulation of average regional climate change is the inter-model variability, with the inter-emission-scenario and internal model variability playing secondary roles. To account for these uncertainties, it is widely recommended (e.g. Houghton et al. 2001, Hulme et al. 2002) and adopted (e.g. Alexandrov and Hoogenboom 2000) to use multiple scenarios in climate change impact studies. This is typically done by using a set of scenarios derived from several GCMs and various emission scenarios. Uncertainties in climate change scenarios for the Czech Republic were analysed by Dubrovský et al. (2005).

4.3 Extremes events, sensitivity of processes to climate change

In the summer of 2002 the Czech Republic experienced some of its worst floods in history. For example, the Vltava river inundated Prague causing severe and widespread damage. In the same year, the Elbe and Danube rivers experienced their worst flooding in over a century (Waple and Lawrimore 2003). On the other hand, in the summer of 2003, central Europe was struck by an unprecedented heat wave and severe drought conditions (Schär et al. 2004, Luterbacher et al. 2004, Andersen et al. 2005) causing both human losses, extensive limitation of human activities and damages to natural ecosystems (e.g. Schär and Jendritzky 2004). Several studies suggest that a more frequent occurrence of very extreme events is consistent with climate-change predictions (Christensen and Christensen 2003, Schär et al. 2004, Meehl et al. 2004, Meehl and Tebaldi 2004, Pal et al. 2004). Central and Eastern Europe appears particularly vulnerable with regard to future changes in extremes (Christensen and Christensen 2003, Schär et al. 2004), likely due to regional specificities such as highly varying topography and continentality.

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 (e.g. Frei et al. 2005). Some studies have highlighted the role of large-scale circulation changes (e.g. Meehl and Tebaldi 2004, Pal et al. 2004, Findell and Delworth 2005), but land-atmosphere interactions are clearly of key relevance as well (e.g. Seneviratne et al. 2002, Vidale et al. 2005, Lenderink et al. 2005, Rowell et al. 2005). 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.

4.4 Climate change impact on hydrology and water management

As water is fundamental to human life and many activities, the implications of climate change for the hydrological cycle, water resources and their management are very important. Since the beginnings of concern over the possible consequences of global warming, it has been widely recognized that changes in the cycling of water between land, sea, and air could have very significant impacts across many sectors of the economy, society, and the environment. Consequently, many studies concerning the potential effects of climate change on hydrology (focusing on water cycle) and water resources (focusing on human and environmental use of water) have been elaborated. The majority of these studies are concentrated on possible changes in the water balance or in stream flow through the year.

The impacts of climate change on hydrology usually are estimated by defining scenarios for changes in climatic inputs to a hydrological model, from the output of general circulation models (GCMs). Considerable effort has been expended on developing improved hydrological models for estimating the effects of climate change. Improved models have been developed to simulate water quantity and quality, with a focus on realistic representation of the physical processes involved. These models often have been developed to be of general applicability, with no locally calibrated parameters, and are increasingly using remote sensing data as input. The different hydrological models can give different values of streamflow for a given input (as shown, for example, by Boorman and Sefton, 1997; Arnell, 1999a), the greatest uncertainties in the effects of climate on streamflow arise from uncertainties in climate change scenarios, as long as a conceptually sound hydrological model is used.

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. The precipitation is the most important factor of variability in the water balance over space and time, and changes in precipitation have very important implications for hydrology and water resources. In a river basin the hydrological variability over time, is influenced by variations in precipitation over daily, seasonal, annual, and decadal time scales. Flood frequency is affected by changes in the year-to-year variability in precipitation and by changes in short-term rainfall properties (Osborn et al., 2000). The frequency of low or drought flows is affected primarily by changes in the seasonal distribution of precipitation, year-to-year variability, and the occurrence of prolonged droughts.

Evaporation from the land surface includes evaporation from open water, soil, shallow groundwater, and water stored on vegetation, along with transpiration through plants. Climate change has the potential to affect all of these factors—in a combined way that is not yet clearly understood— with different components of evaporation affected differently.

The soil moisture contents are directly simulated by global climate models, even though over a very coarse spatial resolution, and outputs from these models give an indication of possible directions of change (Gregory et al. ,1997). The local effects of climate change on soil moisture, however, will vary not only with the degree of climate change but also with soil characteristics.

Groundwater is the major source of water across much of the world, 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 greatest number of hydrological studies, into the effects of climate change, has concentrated on potential changes on streamflow. To estimate the impact of climate change on the hydrological resources, mathematical rainfall-runoff models are commonly used for the reference (pilot) basins. Moreover these basins are selected based on the assessment of the vulnerability of water resources and corresponding adaptation measures. Generally, these mathematical models can be applied both in the case of present regime (actual climate) and regimes of climate change scenarios taken from downscaled results. When taking the results of statistical downscaling techniques, the use of weather generators is required to obtain proper inputs for most hydrological models, however, in the case of very high resolution RCMs both spatial and time resolution could be satisfactory for direct input to the basin models.

Usually, the interest in climate change impacts on hydrology is based on the assessment of water quality changes and availability and management of surface water resources. This implies the analysis of hydrological balance changes, nutrient (N, P) concentrations and eutrophication in a reference river network with reservoirs used for drinking water supply and recreation.

4.5 Climate change impacts on agriculture and forestry

Atmospheric CO_2, which is the primary source of carbon for plants, is in its current concentration sub-optimal for C3 type plants (Hall, 1979) and therefore the increased content of CO_2 in the air stimulates photosynthesis even though some experiments seem to suggest that the increase of the photosynthesis intensity vary during the phenological phases (e.g. Mitchell et al., 1999). AT the same time, higher ambient CO_2 allows to reduce the transpiration intensity through decreased stomatal conductance, especially under higher temperatures (Bunce, 2000). This should lead to improved water use efficiency by plants (WUE) and thereby to a lower probability of water stress occurrence (Kimball, 1983). Experiments conducted in controlled environments indicate that the winter wheat growth and biomass production might increase up to 33±6% (e.g. Cure and Ackock, 1986) at doubled ambient CO_2. Some studies also showed that the variability in these wheat responses to CO_2 enrichment is very high (e.g. Wolf et al., 2002; Bender et al., 1999). A comprehensive review of 156 experiments (Amthor, 2001) with winter wheat that were carried out during the years 1976-2001 supports these claims. 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, spring barley (and all cereals in general) yields typically decrease with increasing temperature due to a shortening of phenological phases (Batts et al,. 1997; Brown and Rosenberg, 1997). 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 (Porter and Gawith, 1999).

Forest response to 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 (IPCC, 2001b). Forest growth has increased during the past several decades in European forests (Spiecker et al. 1996). Climate warming, increasing CO2, increased nitrogen deposition, and changes in management practices are factors that are assumed to be behind the increase. The impacts of temperature and CO2 have been shown in experiments and are extrapolated by model calculations (Keller et al., 2000, Mindas et al., 2000).

There are major gaps between the actual and attainable yields of crops, attributable largely to pests, diseases and weeds (Oerke et al., 1995). In global change research, estimates of crop yields using simulation models also suffer from major gaps between observed and predicted yields (Landau, et al., 1998). Furthermore, invertebrates and plant pathogen (in this proposal term "pests" include also plant pathogens) are highly adapted to change and so are prime targets for risk assessment in global climate change. 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. Pest -host relationship can be affected by climate change in different ways. Pests that are currently of minor significance may become key species, thereby causing serious damage in European countries (IPCC, 2001a). 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. It is also apparent that pests will migrate as crops migrate (e.g. Lipa, 1999) in association with climate-induced changes in crop composition. At the same time the pesticide usage will change thus leading in some cases to an increase of production costs (Chen and McCarl, 2001).

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. It has been also noted by Rosenzweig et al. (2000) that ranges of several important crop pests in United States have expanded since the 1970s, including soybean nematode and corn gray blight. These expansions seem to be consistent with climate trends, although there are competing explanations. The IPCC (2001) report also highlights the importance of specialized model use as a tool for understanding development dynamics of various pests and diseases under changed climatic conditions (e.g. Teng et al., 1996).

4.6 Climate change impacts on air quality and health

The atmospheric air is contaminated with pollutants that may adversely affect health. These pollutants have many sources: natural (e.g., volcanoes, forest fires and decomposition of vegetation), industrial (e.g., fossil fuel-fired electric power plants and manufacturing facilities), transportation (e.g., truck and automobile emissions), residential (e.g., home and municipal coal, gas and oil burners, wood stoves and municipal waste combustors), agricultural (e.g., ammonia, methane and pesticides), commercial (e.g., dry-cleaning operations, commercial facilities, many individually small activities such as gasoline service stations, small paint shops, consumer solvent use). People are constantly and ubiquitously exposed to air pollutants, whether indoors or outdoors.

Climate change may affect exposures to air pollutants by a) affecting weather and thereby local and regional pollution concentrations (Robinson, 1989); b) affecting anthropogenic emissions, including adaptive responses involving increased fuel combustion for fossil fuel-fired power generation; c) affecting natural sources of air pollutant emissions (U.S. EPA, 1998); and d) changing the distribution and types of airborne allergens (Bernard et al., 2001). 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 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 (WHO, 2000). The most sensitive groups include children, older adults and persons with chronic heart or lung disease. A simple schematic illustrating how potential climate change affects air-pollution and health is shown in Fig. 2.

Of the few studies that have attempted to quantify the potential effects of climate change on air quality, most have examined the impact of increased temperature on O3 formation (Morris et al., 1995). In general, these studies find that O3 concentrations increase as temperatures rise, although the estimated magnitude of the effect varies considerably. However, the ability of atmospheric models to simulate complex photochemical reactions in the atmosphere is limited for several reasons, including uncertainties in emission inventories and boundary conditions when we refer to regional air quality modeling. Further, several of these studies relied on assumptions for key variables such as emission levels, mixing heights, and cloudiness.

Because many aspects of weather affect air quality, and most of these have been held constant in modeling studies, the results of these studies should not be considered predictions of future air quality levels associated with climate change. Rather, they demonstrate the sensitivity of atmospheric air pollutants to changes in specific meteorological variables as well as emission levels.

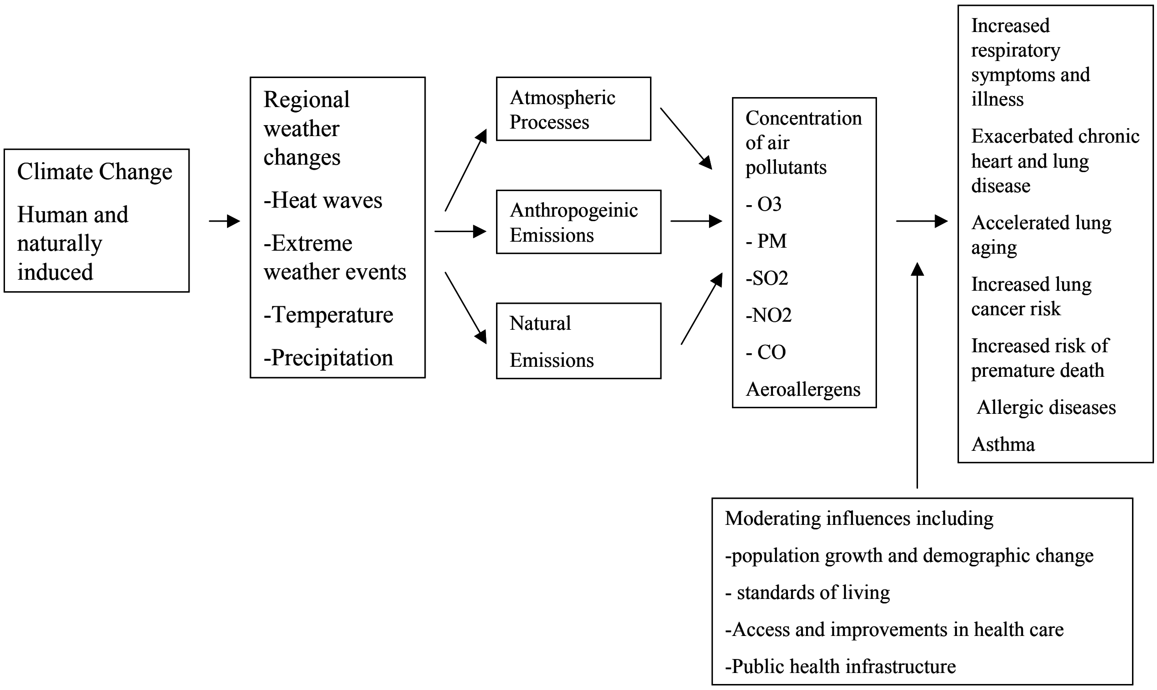

Figure 2. *Potential climate change effects on air-pollution and health (adapted from Bernard et al., 2001).*

Another risk factor for human health, which goes hand in hand with the issue of air quality through the chemistry of pollutants, is the occurrence of heat waves and, to a 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 matural ecosystems. The links between the occurrence of such extreme events and anthropogenic forcings and the consequences for human health and mortality are widely discussed by Beniston and Stephenson (2004), Schär et al. (2004), Pal et al. (2004), Meehl et al. (2004) and Meehl and Tebaldi (2004).

5 Potential impact

The issue of global change is recognized and taken into account under the UN Framework on Climate Change as having potential of serious consequences for the natural environment and human societies. This is particularly the case for the EU, which has taken the lead among industrialised countries in calling for reductions in greenhouse gas emissions and establishing policies to achieve such reductions within its own borders. Although the broad response of global climate to increased greenhouse gas concentrations is well established, there remain many unknowns in the regional details of current projections of future climate change.

Previous projects such as PRUDENCE and ongoing projects such as ENSEMBLES provide a significant improvement in the regionalization of climate change implications at the European scale. These projects have proven regional climate modeling to be a very useful tool to study regional climate change. Both PRUDENCE and ENSEMBLES are targeted to Europe-wide scale, where the resources are still a factor limiting the model resolution. The CECILIA proposal targets the smaller area of Central and Eastern Europe, thereby allowing a much finer resolution (10 km), which will provide in this region of complex topography and landuse a further robust test of the feasibility of dynamical downscaling for use in climate change research. 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 latter underpin the formulation of adaptation and mitigation policies. 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.

5.1 Contributions to standards

The CECILIA project will provide a contribution to the improvement of the scientific basis for the implementation of policies to reduce emissions of greenhouse gases. 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 consequenses 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. It will likewise contribute to define future EU standards for agricultural and energy policies. For this purposes, reliable information and results from the research community are necessary for policymakers, keeping the standards of scientific outputs on a peer reviewed basis.

5.2 Contributions to policy developments

This proposal brings for the first time very high resolution localization of climate change scenarios into the targeted areas of central and eastern Europe, with the added value that these climate scenarios are produced locally. This will provide necessary policy relevant information for decision makers and local authorities concerning the possibility of adaptation and/or mitigation measures. Moreover, it will provide know-how and tools which can be further systematically 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 exisiting gaps.

Another significant contribution to EU policy from the proposal CECILIA is the promotion of new massive access to climate change data and simulation within the framework of this topic for researchers from the area of the former Eastern Block. This proposal has already become a platform for spreading the contacts between climate change scientists from the targeted area and the western part of Europe and, as accepted, it will strengthen the collaboration between older countries of the

EU and “newcomers” within the climate change research. In this way, it will help to bridge exisiting gaps.

5.3 Risk assessment and related communication strategy

Climate change will affect quality of life and health through a variety of routes including changes in water resources, new or altered diseases, changes in agricultural productivity and in the profile of economic activity affecting livelihoods, changes in air quality conditions, and raised sea levels resulting in loss of land for human habitation and damage to coastal ecosystems. Although some climate-related changes may ultimately have benefits, the process of change almost always affects the communities and industrial sectors involved in a negative manner.

Several key issues connected with climate change have become of interest in recent years, such as the occurrence of extremes (floods and heat waves) 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. This relation can be better explored using the downscaling and high resolution (10 km) climate modeling planned in the project CECILIA. Results from CECILIA will allow us to evaluate the vulnerability of different sectors in the region, thereby providing relevant information for decision makers and local authorities for application of appropriate adaptation and /or mitigation strategies. 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 also help to identify and possibly exploit positive impacts. CECILIA 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.

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, such as severe storms, droughts or flooding events, than is the situation in the present climatic conditions. CECILIA with its high resolution climate simulation tools can help anticipate and ameliorate the adverse impacts of climate change 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 an effective 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.

The CECILIA proposal is in close relation to the ongoing FP6 EC IP ENSEMBLES and QUANTIFY, with which it will share results and know how. As mentioned above, the activity covered by the proposal is linked to the topic of IPCC and results of climate change simulation generated within the CECILIA project are expected to be available for other interested institutes, universities and research centres in Europe, with the possibility of direct use in many national projects studying climate change impacts over the targeted area.

6 Project management and exploitation/dissemination plans

6.1 Project management

The overall aim of the management of CECILIA is to ensure a smooth running of the project. This will 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 will be fixed in the Consortium Agreement (CA).

Management structure

Management structure of CECILIA is 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 will be assured by the following relevant roles: a) Project Manager, b) Workpackage Leaders, c) Team Leaders, and by means of the Scientific Steering Group. Fig. 3 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 will be specified in the contract with European Commission (EC). For this purpose, the co-ordinator will nominate:

a) A **Project Manager**, who will resume overall responsibility for all the day-to-day project co-ordination matters, assisting and supporting the co-ordinator. The project manager will be 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.

Each partner will nominate a **Team Leader (TL)** who is responsible for managing the team within his company. The TL will be 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 direct the overall project work and activities. Decisions taken by the SSG are binding for the consortium for the duration of the project. Every reasonable effort will be made to have all SSG decisions unanimous. However, after a reasonable amount of time has been allowed to illustration and defence of conflicting positions, in order to avoid deadlock in project operational progress, the approval of a two third majority of SSG will be sufficient. If the decision being taken is unacceptable to partners found in the minority positions, the resolution of the conflict will be elevated to each Partner's higher executive level. Either the SSG or the Project Manager can initiate the conflict resolution procedure.

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 WL will be appointed by the partner, which is designated as responsible partner for the specific WP.

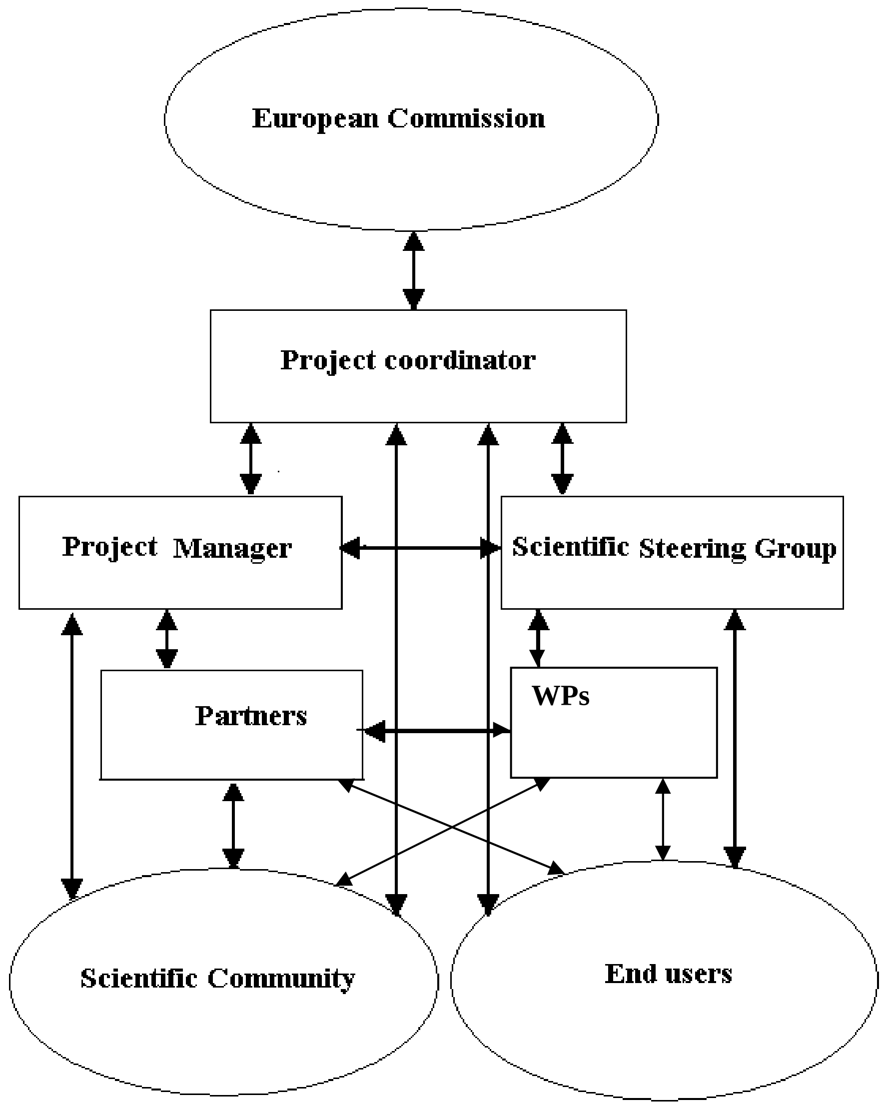

Figure 3. *Management structure*

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

Project Communication Flow

The communication flow between the partners will be continuous. Extensive use of e-mail will be made for the day to day communication between partners of the consortium. A web site promoting the CECILIA results and disseminating information about the project will be constructed. An extranet site will ensure a broader and more efficient communication. Regular meetings will be held at least every nine months, but in case of unexpected and/or extraordinary circumstances additional meetings can be held in between regular meetings. The locations of these meetings will rotate through the partners' locations. Links with other related projects will be established through an active information exchange process and - if possible - by attending other projects' technical review meetings, as well as through the usual Commission concertation process. The Project Manager will be responsible for establishing these links with other related projects.

All technical documentation generated by the Project should be exchangeable in electronic format, according to a set of guidelines to be agreed very soon at project start-up. Adherence to these guidelines will be enforced by the Project Manager. Only strictly formal correspondence will be exchanged by ordinary mail and telefax. Exchange of information will mainly occur by e-mail and file transfer over Internet. A WEB project document repository will be made available by the Co-ordinating Partner. Telephone and fax will be used for urgent needs only. Urgent correspondence over e-mail will be sent with a request for explicit acknowledge. Ordinary mail will be used for strictly formal correspondence, i.e. when executive signatures are required. Adherence to the agreed communications standards will be enforced by the Project Manager.

Project Reporting and Quality Control

Periodical Progress Reports (PPRs) shall be issued by the Project Co-ordinator with the purpose of describing the work done during the past period by each partner, and compare results with the established workprogramme. The Project Manager shall be in charge of collecting relevant information from all the partners, and Project Co-ordinator shall prepare progress reports to be forwarded to the Commission. The structure of such Reports shall correspond to the rules of the Commission and should contain:

- Executive Summary (updated “Project Snapshot”)
- Description of work undertaken, work completed and work delayed
- Milestones accomplished
- Deliverables completed and issued, and percentage of completion of each deliverable
- Task delays, corrective actions taken, and changes to the programme (if any)
- Work to be undertaken during the immediately following period
- Actions for dissemination of (partial) results
- Revised work schedule (if applicable)
- Indicative effort spent per partner, per task
- Updated exploitation plan (if applicable)

Confidentiality and Intellectual Property

Matters related to Confidentiality and IPR handling will be defined in the "Consortium Agreement for CECILIA”. Project-related publications will require a notification to SSC. These should contain an acknowledgement of support by project together with a disclaimer that the views are not necessarily those of the Consortium.

Management a Project Meetings

Progress in the work on the project as well as management issues will be discussed on Management Meeting held in connection with Project meetings which are supposed to be scheduled at least each 9 months. and they will be followed by technical workshops in order to co-ordinate our work. The meetings will include review of any reports due to be delivered shortly afterwards, so that Formal Document Reviews will be the principal quality control that will be exercised on the project. Reports will be written to a project standard using a common word processor. The use of Project Planning software and regular reviews is designed to measure and to help achieve realistic measurable targets.

The Project Manager will define an outline **risk management** plan, covering any WPs on whose outcome other work packages are dependent. Various unplanned events can take place during the Project duration, and it is planned to allocate some people in the Project as deputies to others (e.g. illness or holidays may make this necessary). Similarly, the Project Co-ordinator may need to stand in for the Project Manager on occasion. As well as providing for unforeseen contingencies, this will also have the benefit of familiarising partners with work that others are undertaking, and allowing appropriate synergies to develop.

6.2 Plan for 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). 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.

The CECILIA dissemination & exploitation strategy will evolve throughout the whole project duration, running in parallel to the other activities. The aim is to analyse and identify the reality within which the CECILIA is going to operate, through the definition of potentialities and problems, so as to bring this project to success. To this end it will analyse input that will be collected during the first phases. Dissemination activities will aim at diffusing on a global scale the project results.

All partners will participate in the analysis and exploitation plan activities of the project covered under tasks 1 and 3 that are presented below. The exploitation focus of the participants will be in alignment with their individual exploitation plans. Finally, all partners will participate in the dissemination activities, covered under tasks 2 and 3.

Task 1. Definition of the Exploitation Strategy: In this task an in-depth analysis of the CECILIA application domain will be made, covering central and eastern Europe and Europe as a whole. This task will exploit the results of the identification of the existing stakeholders and potential users and define their involvement and level of interaction.

Task 2. Definition of the Dissemination Strategy: This task involves the identification and design of promotion activities, and the preparation of the dissemination plan for the project results, including the preparation of the required marketing material (newsletters, brochures, WWW pages etc.). Additionally, it is going to present the final results and achievements, and to monitor relevant activities through the participation to conferences etc.

Task 3. Dissemination and Exploitation Activities: Apart from the exploitation of the complete CECILIA output, the exploitation and dissemination of scientific results will be the major task of all the research institutes involved. Demos and supporting papers at targeted conferences and certain public events will promote the results of CECILIA.

6.3 Raising public participation and awareness

As mentioned above the CECILIA project shall provide a contribution to the improvement of the scientific basis for implementation of the policy to reduce emissions of greenhouse gases. The CECILIA team will provide the experience and knowledge based on the analysis of local and regional impacts of climate change to endusers interested, as well as to stakeholders or decision makers. Appropriate contribution to media will be provided to spread the awareness of the possible consequencies of climate change and information towards the definition of future EU agricultural and energy policies will be issued when available. For this purposes, reliable information and results from the project shall be available for policymakers and local authorities. On more general platform, presentations of the partners in their countries at different local public workshops, seminars or conferences are expected as well.

7 Detailed Implementation Plan – for full duration of the project

The project PRUDENCE was a prototype for joint regional climate modelling within the European Union. Its successor, the Integrated Project ENSEMBLES has been developing further this integration. It is not possible to approach the objectives of climate change impact studies without a high degree of integration and multidisciplinarity. At the European level, this effort requires resources beyond the level of a STREP. However, the smaller regional area of interest of CECILIA allows it to integrate across modelling activites and across disciplines within the framework of targeted objectives of interest to the region. In this sense CECILIA is an extension and development of PRUDENCE and ENSEMBLES. On the other hand, within the limits of STREP it is not possible to provide complete analyses, rather examples of climate change impacts analysis are provided based on the firm background of regional climate modelling.

The proposal CECILIA brings for the first time very high resolution localization of climate change scenarios into the targeted areas of central and eastern Europe. Improving upon the project ENSEMBLES where Europe-wide scale is adopted at high resolution, in the CECILIA proposal we address even higher resolutions on a significantly smaller domain, which is affordable with lower computer resources and allows to address more targeted problems. 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. On the other hand it requires the adaptation of parameterizations available at coarser resolution, which will constitute an important feedback with global and broad resolution modeling. 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.

7.1 Introduction - general description and milestones

The objective of the project is the assessment of climate change impact in the regional scale for territory of the central and eastern Europe with emphasis to very high resolution which is necessary with respect to the complex terrain of the region. This will be achieved mainly based on regional simulations using RCM studies, statistical downscaling will be used as well for comparison. On this background, the most important or from previous studies the most vulnerable sectors of individual countries economies and life, the impact of climate change will be studied. These aims give us following key elements of the project reflected in the structure of workpackages as documented in the Table of WP.

- Analysis of available scenarios and impacts studies (PRUDENCE, MICE, ENSEMBLES) where available already, application for CEE - WP1, leaded by Giorgi (ICTP)
- To adapt and develop the very high resolution RCM (10 km), to perform regional time-slice nested simulations for selected GHG changes scenarios as well as simulation driven by ERA40 - WP2, Deque (CNRM)
- To verify the model results, compare to statistical downscaling and analyze and develop the methods for verification and output localizing - WP3, Huth (IAP)
- To estimate the effect of global climate change on the occurrence of extreme events (heavy precipitation, heat waves, droughts) in the region, including the assessment of the added value of high-resolution experiments for the simulation of the relevant processes and feedbacks - WP4, Seneviratne (ETH)
- To assess (based on the high resolution downscaling results) the impacts an vulnerability of climate change in hydrological cycle and water resources in main selected catchments, to study the effects on Black Sea - WP5, Mic (NIHWM)

- To study (based on the high resolution downscaling results) the climate change impacts an vulnerability in agriculture and forestry, impacts on carbon cycle, selected species - WP6, Hlasny (FRI)
- To study (based on the high resolution downscaling results) the impacts on health and air quality (photochemistry of air pollution, aerosols) - WP7, Juda-Rezler (WUT)
- Management, reporting and dissemination - WP8, Halenka (CUNI)

Each of the elements will operate as a separate work package, supervised by one of the project partners. All the WPs are running more or less in parallel and thus covering all the period of the project running, however, there are strong dependencies in line global data (WP1), boundary conditions and RCM simulations (WP2), validation and analysis (WP3 and 4, respectively), and climate change impacts (WP5,6 and 7). All this sequence will operate in principle four times, for ERA40 reanalyses, for present climate GCM simulations and scenarios time slices for the middle of the century and at the end of the century. In addition to RTD WPs, the project will include a package devoted to project co-ordination, monitoring, reporting and dissemination (WP8). The content of the RTD WPs are discussed in more detail below, WP8 (Management, data reporting and dissemination) has been already discussed in detail in chapter 5 (Project management).

Implementation plan – climate change

During the last decade RCMs have been increasingly used to examine climate variations at scales that are not resolved by global models. To the extent that they produce realistic climate simulations, such models can be powerful tools in the study of regional climate impacts. Since the field of regional climate prediction is still evolving, the skill of RCMs in simulating climate variability has not been extensively evaluated. This is planned within the framework of the project ENSEMBLES for simulations of 50 to 25 km resolution driven by ERA40 reanalyses. As part of the ENSEMBLES project transient scenario runs of one hundred year length (and some longer) are also planned under different greenhouse gases (GHG) and aerosol forcing. In this proposal we plan a detailed analysis and use of the results of the project ENSEMBLES for focused initial impact studies in our target region (WP1 and starting stage of WP4,5,6,7). However, next to this initial phase, the main objective 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, which will provide additional information related to the complex terrain of the region. 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 and size of the model domain. Moreover, 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 will provide a connection with the EC FP6 Project QUANTIFY, which aims at quantifying the impact of transportation on climate change. Our project will also provide insights on the validation and relative merits of statistical and dynamical downscaling, in particular as applied to provide fine scale climate information.

The most reliable source of information about the evolution of the atmospheric environment in the next decades comes from RCMs. IPCC-WG1 at the international level, and PRUDENCE at the European level have demonstrated that beyond the individual behaviour of the RCMs, a convergence in the response at the end of the 21st century is observed. A problem appears if one considers the climate response at the middle of the century. The different IPCC scenarios (A2, A1B, B1) provide a similar forcing, so that this is not a major cause of uncertainty. But the climate system produces its internal variability, on annual and decadal scale, and the amplitude of these variations dominates the response to GHG increase till 2050. As this shorter range is important for adaptation purpose, we need to provide more than one scenario to impact participants. A single climate scenario would propose, for example a cooler phase during the 2030s and a warmer one during the 2040s that are only the expression of the climate chaotic behaviour of a particular experiment. 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.

Using 10 km resolution in climate simulations is a new approach which needs to be validated with care, if one wants to give some credibility to the proposed scenarios. 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 for the 1958-2002 period. The other 3 RCM simulations are snapshots driven by GCM conditions: 1961-1990, 2021-2050, and 2071-2100. The first simulation is necessary for a reference to the other twos: A simulation forced by ERA40 may have different characteristics and we want to analyze only the response to GHG concentration, not to the systematic errors of the GCM.

WP3 provides an interface between climate models (both global and regional) and climate change impact assessments. It utilizes outputs from WPs 1 and 2, 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. Finally, WP3 consists of four distinct but interlinked tasks: statistical downscaling, output localization, model validation, and construction of climate change scenarios.

In statistical downscaling, several frequently used methods will be employed. As target variables, temperature (maximum, minimum, mean) and precipitation will be used; other variables will be downscaled if impact sectors (WPs 5 to 7) claim their necessity for the impact models. The target variables (predictands) will be defined in daily and monthly time steps. The methods include: (i) multiple linear regression (MLR) from gridded data and predictor's principal components, (ii) canonical correlation analysis (CCA), (iii) nonlinear methods – artificial neural networks and local models in phase space, (iv) linear methods applied to data stratified by classification of circulation patterns, (v) MLR and CCA for seasonal distribution characteristics, followed by stochastic generation of daily values (or, more generally, a conditional weather generator). 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). The innovative feature is targeting to the area of central-eastern Europe, which tends to have been overlooked in previous detailed downscaling studies, having concentrated on other European areas, such as the Alps, Scandinavia, British Isles, and Iberian Peninsula. A considerable step forward can also 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 unncecessary; 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. This, together with validation of driving GCMs as for their ability to simulate SDS's predictors, will ensure that the assumptions of a correct use of SDS methods are met. For the validation, the dataset will be divided into the training and validation parts; the cross-validation framework (Michaelsen 1987) may also be considered where feasible. 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).

For validating the results of the sub scale surface scheme (WP2), an up-scaling of snow observations instead of output localization will be performed. As snow cover is not only a function of the actual weather conditions, it also contains some "memory" about the situation of the whole accumulation period, the up-scaling to the RCM scale of 1 km is more realistic. The up-scaling will use geo-statistical methods, applied on dense snow observations, using a high resolution digital elevation model (Böhm and Potzmann 1999).

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. In addition to it, several smaller-scale dense nation-wide datasets will be utilized, with emphasis on the target areas for the impact assessments. The target areas include, among others, the Czech Republic, Romania, Austria, and two hydrologically sensitive parts of Hungary, the watershed of the Lake Balaton and the Great Hungarian Plains. 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 may be 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. 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.

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.

The workpackage WP4 will for its part deal with the analysis of the impact of climate change on the occurrence of extreme weather events in Central and Eastern Europe. The participants to this WP are ETH (lead partner), DMI (co-lead partner), CUNI, NMA, CHMI, ELU, IAP, OMSZ, ICTP, AUTH, and NIMH. In the first stage of the project, WP4 will 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 partners, together with the selection of the sets of extreme indices (WMO, STARDEX) relevant for the analysis. (D4.1, D4.2)

A second focus of WP4 will be the assessment of the added value of 10km resolution for the simulation of extremes. First, existing daily model output (GCM, 50km, 20km as well as one set in 12km resolution) can be obtained through the data servers of the EU projects PRUDENCE and ENSEMBLES or from DMI. 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. (D4.3, D4.4, D4.5)
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, heat waves, 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)
Studies for the whole region will be 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. CHMI, IAP and CUNI, will lead the analyses for the Czech republic, ELU and OMSZ, the analyses in the Carpathian basin, NMA the analyses for Romania, , and NIMH the analyses for Bulgaria. ETH and ICTP will collaborate on sensitivity and process studies, with contributions from CUNI.

Implementation plan – climate change impacts

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

For assessing the impact of the climate changes upon the water resources, the WATBAL model is used, a water balance with monthly time step, combined with the Priesley-Taylor method for calculating the potential evapotranspiration. The temporal input data series of this model include: the effective precipitation (corrections for the seasonal interception on plants, those with the altitude and measurement errors should be predefined), the potential evapotranspiration, and for calibration and validation, the flow in length/time units. The potential evapotranspiration could be estimated using the Priestly-Taylor sub-component, in which the temporal series of temperature are also necessary. For the catchments in which the snow melting has an important role, it is used a model that uses the index of melting temperature, with temperature thresholds for melting and frost. The model for the snow melting is also used for calculating the albedo during the winter period, in those basins in which during the winter the snow precipitation is important.

The rainfall-runoff model is used for the simulation of the river flow in two scenarios (actual climate and modified regime). The input meteorological data (precipitation and temperature) and the model parameters should be considered as average values over the basin area and will be provided by WP2 and WP3 except first stage when for further comparison and model setting WP1 will provide data from previous projects. Such condition may be met provided that the basin area is sufficient small (a couple of hundreds of square kilometres). The application of model as a first step in estimating the climate change impact on the hydrological resources will be performed on the reference basin.

In order to calibrate the model the monthly flows over a selected period will be simulated. The influence of the hydraulic works in a river basin upon the water supply is studied with the ARTIZAN model. The program applies, chronologically at every time steep, the balance equation of the discharges, for every reach of the cascade, in the upstream-downstream order.

In order to assess the vulnerability of the water resources under the climate change conditions, the series of mean monthly discharges in several points of the reference basin will be needed. These points refer to the locations of the reservoirs water, diversion and restitution works where the water resources - demands budgets are to be performed. The assessment of the monthly flows in these points will be done by means of a correlation function between the station at the outlet of the reference basin and other gauging stations in the analysed basins. The correlation function will be determined on the basis of the recorded data over a 30 years period at the gauging stations located in the analysed basins. It is assumed that the correlation function between discharges in different points of the analysed basins, determined for the current climate, maintains in the modified climatic scenario.

Impacts of the climate change on water quality in surface water resources will be assessed with a modelling system consisting of a catchment and stream water quality model (HSPF) and 2-dimensional dynamic reservoir model (CE-QUAL-W2). The HSPF model (http://water.usgs.gov/software/hspf.html; Bicknell et al. 2001) was developed for simulations of precipitation-runoff process and selected water quality constituents (suspended solids, phosphorus, nitrogen, oxygen, pesticides) in the runoff from catchment. Processes in the river network can be included in the simulations. The CE-QUAL-W2 (http://www.ce.pdx.edu/w2/; Cole and Wells 2002) is used to model hydrodynamics and water quality (temperature, dissolved oxygen, algae, phosphorus, nitrogen, organic matter) in longitudinal and vertical transects of stratified reservoirs.

Impacts of climate change on crop growth and development in WP6 may be estimated by crop models, which utilize mathematical modeling approach to simulate the development of individual parts of the plants, commonly in daily steps. The crop models frequently used to simulate the growth and development include CERES (Trnka et al, 2004, Žalud and Dubrovský, 2002), WOFOST Alexandrov and Eitzinger (2002) or other models (e.g. STICS, CROPSIM etc.). The effect of the climate change is estimated by comparing model crop yields simulated with use of weather series representing the present climate and the changed climate. The weather series for the changed climate conditions can be prepared e.g. by stochastic weather generator parameters of which were derived from the observed weather series and then modified according to the climate change scenario (Semenov and Porter, 1995; Riha et al., 1996; Semenov and Barrow, 1997; Dubrovský et al., 2000). The model simulations are performed under two sets of conditions. In unlimited conditions, the plant is given as much water and nutrients as it needs. In this case, no water stress and nitrogen stress may occur, and the resultant yields are referred to as the potential yields. In limiting conditions, water and nutrients supplies are limited and the stressed yields are simulated. The climate change impact studies focus mostly on (i) impacts of an increased CO2 concentration on the crop growth and development (ii) possible adaptations through changes of the cultivar and sowing dates. The latter issue is addressed, e.g., by Alexandrov and Eitzinger (2002), Cuculeanu et al. (1999), Wolf and van Diepen (1995), Žalud and Dubrovský (2002).

In the case of the pest and diseases climatic mapping reviewed by Sutherst (2003) is reliable method for predicting their potential distributions under current and future climates. At its simplest, the process of climatic mapping examines the climate in an organism’s home range and compares it with the climate in the area being assessed for potential colonization or the climate in the same areas under a climate change scenarios. The new direction in the climatic mapping was started by CLIMEX dynamic model (Sutherst and Maywald, 1999) that is used to infer species´ responses to climate from observations of the geographical distribution and seasonal abundance. It is a climate rather than weather driven modeling program that is design to provide insight into species requirements for climate as expressed by their geographical distribution, seasonal phenology and relative abundance. It is based on the premise that it is possible to define climates that are conducive to the generation of particular weather patterns, which directly affect populations on a short time-scale. Thus, for example, some plant pathogens require a very specific, short period of leaf wetness that is only described precisely by local weather data with resolution as short as few hours (Sutherst et al., 2000).

As the application of the CLIMEX model will be one of the innovating features of the proposed project special attention will be paid to the model proper calibration using the baseline database. Another modeling tool i.e. DYMEX (Maywald et al., 1999) will be also tested as the second option. It is the modular modeling package that allows the user to develop and run deterministic population models of biological organisms rapidly. Despite the fact it is a promising direction of modeling and focuses on the population of the studied pest directly it has been up to now used only in limited number of studies, as it requires detailed input data. In case that this model proves to perform well for selected pests it will be used in combination with the CLIMEX model in the study.

Adaptation to a changing climate may occur in several forms, including technical innovations, changes in agricultural land use, crops and areas (using a crop cultivar more suited to the new climate) changes in agrotechnology (e.g., planting terms, irrigation and fertilisation regime) up to complete abandonment of the agriculture production. Several adaptation measures will be considered in this project: a) optimisation of the crops; b) optimisation of the fertilisation and soil tillage regimes; c) changes in planting date; d) changes in cultivars. In the last case, the genetic coefficients will be modified within the reasonable range and the optimum cultivar attaining maximum yields and minimum variability (implying low risks) will result from the analysis. The optimum values of individual adaptation options will be identified based on the means (the higher the better) and variability (the lower the better) of the yields obtained during the multi year crop model simulations. Based on obtained results, the optimum cultivars will be assigned to individual soil-climate polygons. The special attention will be devoted to the soil climate areas most vulnerable to expected climate change

One of the most important adaptation measures in the plant protection is to build up a knowledge about the potential risk and built a capacity to respond in case of need. The results provided from general CLIMEX/DYMEX models will be therefore used: (i) in present climate – for pest forecasting, optimization of the crop protection treatments as well as in preparing quarantine provisions; (ii) in changed climate – assessment of the vulnerability of the agricultural sector by newly introduced pests. In the overall the inclusion of the pests and diseases to the study should at least partly reduce uncertainties in the climate change impact assessment arising from non-existing information about the effect of climate changes on the potential distribution and incidence of economically significant species.

There are several models that could be used for the forest growth simulations based on the principles of stochastic methods – gap models (Krauchi 1994). The models are built up to use the response functions (growth parameters vs environmental variables) for the calculations of growth development at stand and regional levels (Lindner et al. 1997). More sophisticated models (e.g. SILVA, SYBILA) combine the principle of gap models with the visualisation and GIS tools.

Clearly an impact of extreme events is extremely difficult to assess. However the project will pay special attention to the changes in the extreme event patterns and will incorporate it in both qualitative and quantitative way to the overall assessment of the climate change impacts on the crop and forest production. Special attention will be paid to the changes in the frequency and severity of the drought events that is generally going to increased under changed climatic conditions in most of the countries involved in the project (Dubrovský et al., 2005). Special attention will be paid to the mitigation strategies including introduction of more drought resistant cultivars or introduction of the more water efficient crops. The potential economical benefit of irrigation and temporal shifts in the growing season will be also assessed at the selected areas. Clearly, whereas for the previous studies data provided by WP2 and 3 will be substantial similarly as in WP5 studies, here the inputs from WP4 will play important role as well.

To fulfill the objectives of WP7 described below the modeling of the interaction between climate and air quality by predictions of air pollution levels in the target regions on the fine scale of the RCM's (10 km) will be performed in close relations to outputs of RCM simulations of WP2.

The concentration of air pollutants depends on many anthropogenic as well as climate factors. A main issue is the quantity of emissions of primary pollutants as well as of precursors of secondary pollutants. Basis for the applied emission inventories will be the EMEP data base, providing emissions of all main pollutants for the years 1970 to 1995 (every 5 years), from 1996 every year and for projections for 2010 and 2020. In addition local data bases will be used for downscaling EMEP data.

Long range transport to the target regions will be taken into account by performing one calculation covering the whole of Europe, driven by RCM with a grid resolution of 50x50 km. The boundary conditions of this continental grid controlled by the global background concentrations have to be estimated. Furthermore these simulations will be used to constrain nested higher resolution runs (10x10 km) for a smaller domain focusing in Central-Eastern Europe both for present and future potential climate. The key species to be simulated will be ozone, sulphur and nitrogen species 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. Two important aspects which have to be considered with caution are a) the emission inventories to be used to constrain the air-quality models for the future projections and b) the chemical boundary conditions for the regional domain. If we consider that the results of these studies should not be considered as predictions of future air quality levels associated with climate change but rather demonstrate the sensitivity of atmospheric air pollutants to changes in specific meteorological variables, we may keep constant important constraints such as future emissions or chemical boundaries of the regional domain.

With respect to the amount of computing time and storage requirement, only 10 years will be calculated for each of the four prospected time intervals. The output of the European runs will serve as boundary condition for runs on the fine grid scale of the RCM's. If the RCM is RegCM, the output may be used directly by one-way-nesting, in the case of ALADIN as RCM averaged results (e.g. per season) may be used.

To exploit the sensitivity of air-pollution levels to potential climate change, RCM simulations for future projections and for the control period will be used to drive offline open sources air quality models (CHIMERE, CAMx and CALPUFF) as well as own models. All these air-quality models can be adapted to the meteorological input data from several RCM's.

- Comprehensive Air quality Model with eXtensions (CAMx), available at http://www.camx.com, from ENVIRON International Corporation (Novato, California) is an Eulerian photochemical dispersion model that allows for integrated "one-atmosphere" assessments of gaseous and particulate air pollution (ozone, PM2.5, PM10, air toxics) over many scales ranging from sub-urban to continental. CAMx include multiple gas phase chemistry mechanism options such as CB-IV and SAPRC99.

- CHIMERE available at http://euler.lmd.polytechnique.fr/chimere/ is an air-quality simulation model with several options making it a flexible tool for detailed episode analysis as well as forecasting or long-term simulations. The user has the choice of running the model with the aerosols or only gas-phase species. The chemical mechanism is optional: it contains mechanisms MELCHIOR1 and MELCHIOR2. Other mechanisms can easily be introduced as far as the gas phase is concerned.

- CALPUFF from Earth Tech (formerly Sigma Research) is a multi-layer, multi-species, non-steady state puff dispersion model which can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF can use the three-dimensional meteorological fields computed by the CALMET model. CALPUFF contains algorithms for near-source effects such as building downwash, transitional plume rise, partial plume penetration, and subgrid scale terrain interactions as well as longer range effects such as pollutant removal (wet scavenging or dry deposition), chemical transformation, vertical wind shear, and over water transport. Most of the algorithms contain options to treat the physical processes at different levels of detail, depending on the model application.

The participants within WP7 will be WUT, BOKU, AUTH, NIMH, CUNI, CHMI and CNSPMP. The tasks of the individual research teams will be the following:

- WUT will concentrate on SO2, sulphates, NOx, and PM concentrations in the target region of Poland for country scale, and selected local areas (e.g. chosen voivodeships in Poland). As a modelling tools both own models as well as open sources models will be used driven by ALADIN-CLIMATE. An interface has to be written for coupling RCM models results to the air pollution models. For regional (country) calculations the numerical two-dimensional Eulerian grid air pollution model for Poland (POLSOX-II), developed at WUT to calculate sulphur species concentration/deposition resulting from point and area emission sources will be used. The model operates at a computational grid, which covers Poland (900 km x 750 km) and constitutes a part of the EMEP model grid, with finer spatial resolution (30 km x 30 km). When developing the model the following assumptions were made: the model should be operational, relatively simple, supported by readily available input data, computationally fast and adequate for long-term regional scale calculations. In order to meet these requirements the model's code contain necessary simplifications. The model has been extensively used for regional scale calculations, model results were positively verified with data from the National Network for air quality monitoring. For local scale CALMET/CALPUFF modelling system will be applied. CALMET/CALPUFF has been implemented and used for many local scale applications in Poland, for point, area and line sources, with the chemical scheme MESOPUFF (SO2, SO4, NOx, NO3, HNO3). Recently the following species have been included: PM10, PM2.5, secondary aerosols, BaP, as well as fractions of HM and PAH in PM10. The modelling results will be further used in the impact studies of WP 6.

- BOKU will use the Comprehensive Air quality Model with eXtensions (CAMx) and concentrate on ozone chemistry. A run for the European domain with 50 km × 50 km resolution will be performed for 10 years in the time slice 2020 to 2050 driven by RegCM (ICTP runs from ENSEMBLE). In addition fine resolution runs will be performed for a smaller domain (10 km × 10 km resolution) covering at least Slovakia, Hungary, the east of Austria and neighbouring regions for the same period, driven by RegCM-results as well as ALADIN-results from WP 2. This will serve for comparisons between the two driving models. The model performance will be checked with runs for shorter episodes from the ERA40 and 1960-1990 time slice. The model results may be further used in the impact studies of WP 6.

- CUNI/CHMI will concentrate on SO2, sulphates, NOx, O3 and VOCs concentrations. As modelling tools both own models as well as open sources models will be used driven by RegCM and ALADIN-Climate. CUNI will run off-line couple of RegCM and Comprehensive Air quality Model with eXtensions (CAMx) for shorter time slices in the framework of ERA40, present climate and scenarios runs. CUNI will test their own SMOG Lagrangian model for photochemical reactions, based on puff model principles, as well as in these time slices. SMOG can be used for improvement of inclusion of point sources. CHMI will run off-line couple of ALADIN-Climate and CAMx for shorter time slices in framework of ERA40, present climate and scenarios runs.

- AUTH will concentrate on ozone chemistry. As a modelling tool AUTH will use the Comprehensive Air quality Model with eXtensions (CAMx) or CHIMERE models. For the validation of the RegCM3/CHIMERE or CAMx offline air quality regional model AUTH will compare model's results with observations as well as with the results of the online regional air quality model WRF-chem for a specific air-pollution episode from the recent past. A first version of WRF-Chem (http://www.wrf-model.org/index.php) was made available as an "online" (or "inline") model in 2002. In this form, the model is consistent, with all transport done by the meteorological model. WRF grid-scale transport of all species is conducted, with subgrid-scale transport by turbulence and convection. The Chemistry Package consists of the components for dry deposition, coupled with the soil/vegetation scheme, two choices for biogenic emissions (online calculation of biogenic emissions that includes emissions of isoprene, monoterpenes, and nitrogen emissions by soil, or the EPA Biogenic Emissions Inventory System (BEIS) version 3.11), anthropogenic emissions computed from the EPA NEI-99 data inventory. The RADM2 chemical mechanism (Quasi Steady State Approximation method with 22 diagnosed, 3 constant and 38 predicted species) is used, photolysis included in terms of Madronich scheme coupled with hydrometeors, inclusion of aerosols (MADE/SORGAM aerosol parameterisation).

Another risk factor for the human health being studied, 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. 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 results of WP4 and simulations of WP2.

7.2 Planning and timetable

More detailed timing of the individual tasks of the workpackages is presented in Fig. 4.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
WP 1	Summary of scenarios available for Central and Eastern Europe																																											
				Finishing ARPEGE Climate simulation 2051-2100 not available from ENSEMBLES																																							
													Summary of impacts studies for CEE from ENSEMBLES																													
WP 2	High resolution parameterization tests, new parameterization implementation																																											
	Sensitivity to model domain choice																																											
							ERA40 runs																																			
										Present time slice 1970-2000																																
													Near future time slice 2020-2050																													
																Century time slice 2070-2100																										
																									Comparison the results with ENSEMBLES, summary																	
WP 3	Data preparation, formulation of validation criteria						RCM output localization methods: development, application to ERA 40 RCM runs																																			
	Development of SDS methods																																											
													Validation of RCM and SDS models																													
																						Production of climate change scenarios																				
																									Comparison of results with ENSEMBLES, summary																	
WP 4	Definitions of indicies, selection of variables						Analysis of available observational datasets																																			
							Analysis of selection of pre-existing RCM data sets																																			
													Analyses of the CECILIA driving-model simulations																													
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WP 5	Hydrological models preparation for high resolution inputs																																											
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																									Climate change impact study, vulnerability assesment																	
WP 6	Crop and forest models, preparation for high resolution																																											
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WP 7	CTM-RCM couple preparation, chemistry parameterization																																											
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WP 8	Management																																											
											Report 1													Report 2																				Final Report	

***Figure 4**. Work planning, showing the timing of the different WPs and their components*

7.3 Graphical presentation of work packages

Schematic representation of the relations between the workpackages is shown by Pert diagram in Fig. 5.

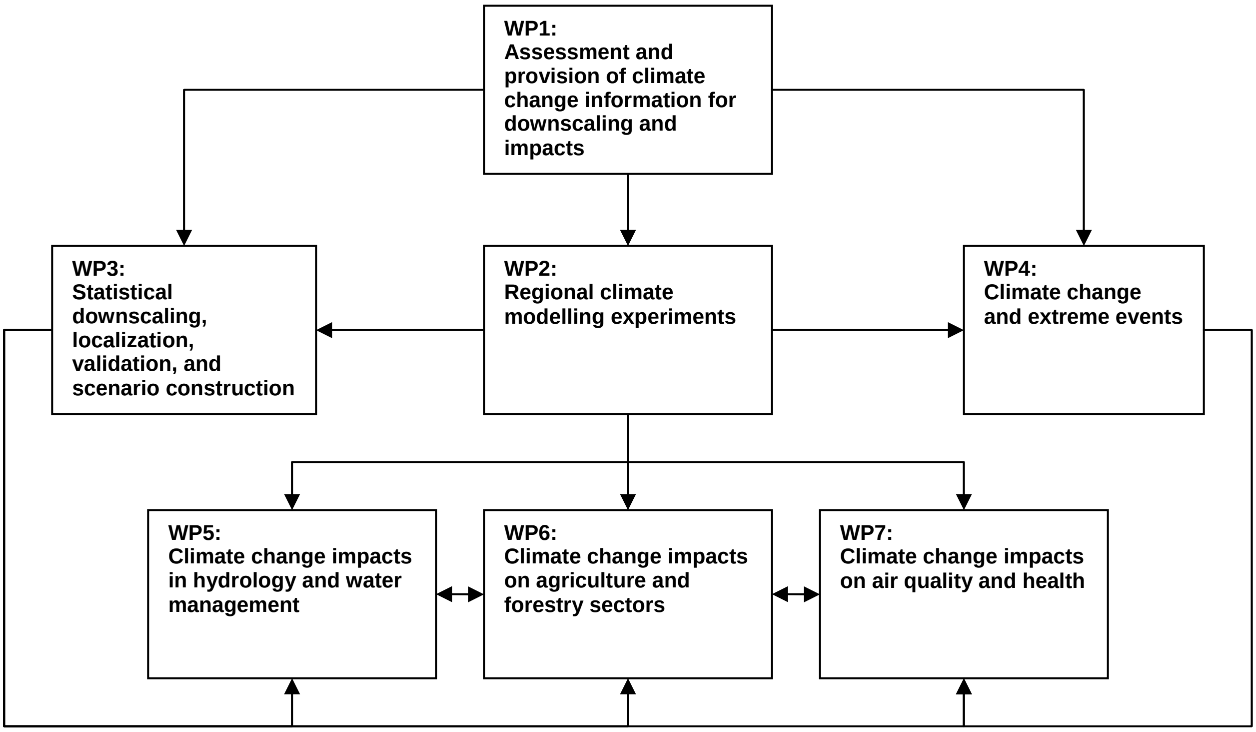

Figure 5*. Interactions between the scientific/technical work packages (Pert diagram)*

7.4 Work package list

WP list (full duration of project)

WP No[1]	WP title	Lead contractor No[2]	Person-months[3]	Start month[4]	End month[5]	Deliv-erable No[6]
1	Assessment and provision of climate change information for downscaling and impacts	2	39	1	18	D1.1-D1.4
2	Regional climate modelling experiments	3	206	1	43	D2.1-D2.7
3	Statistical downscaling, model verification and output localization	7	92	1	43	D3.1-D3.6
4	Climate change and extreme events	8	122	1	43	D4.1-D4.6
5	Climate change impacts in hydrology and water management	12	84	1	43	D5.1-D5.10
6	Climate change impacts on agriculture and forestry sectors	14	127	1	43	D6.1-D6.8
7	Climate change impacts on air quality and health	15	114	1	43	D7.1-D7.5
8	Management, data reporting and dissemination	1	27	1	43	D8.1-D8.7
	TOTAL		**811**			

[1] Workpackage number: WP 1 – WP n.
[2] Number of the contractor leading the work in this workpackage.
[3] The total number of person-months allocated to each workpackage.
[4] Relative start date for the work in the specific workpackages, month 0 marking the start of the project, and all other start dates being relative to this start date.
[5] Relative end date, month 0 marking the start of the project, and all ends dates being relative to this start date.
[6] Deliverable number: Number for the deliverable(s)/result(s) mentioned in the workpackage: D1 - Dn.

7.5 Deliverables list

Deliverables list (full duration of project)

Deliverable No[7]	Deliverable title (with WP identification code)	WP No.	Lead partner	Estimated person month	Nature[8]	Dissemination level[9]	Delivery date[10]
D1	D8.1 Project web site established	8	CUNI	1	R	PU	Month 1
D2	D8.2 Project Presentation	8	CUNI	1	R	PU	Month 4
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	ETH	12	R	PU	Month 6
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	NIHWM	16	R	PU	Month 6
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	FRI	8	R	PU	Month 6
D6	D8.3 Workshop with potential endusers and stakeholders	8	CUNI	1	O,R	PU	Month 6
D7	D1.1 Assessment of climate change information for CEE from previous projects	1	ICTP	12	R	PU	Month 12
D8	D1.2 Provision of climate change information from previous projects for first-stream impact work.	1	CNRM	11	R,O-data	PU	Month 12
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	CHMI	10	R,O-Data	PU	Month 12

[7] Deliverable numbers in order of delivery dates: D1 – Dn

[8] Please indicate the nature of the deliverable using one of the following codes:
- **R** = Report
- **P** = Prototype
- **D** = Demonstrator
- **O** = Other

[9] Please indicate the dissemination level using one of the following codes:
- **PU** = Public
- **PP** = Restricted to other programme participants (including the Commission Services).
- **RE** = Restricted to a group specified by the consortium (including the Commission Services).
- **CO** = Confidential, only for members of the consortium (including the Commission Services).

[10] Month in which the deliverables will be available. Month 0 marking the start of the project, and all delivery dates being relative to this start date.

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	NIHWM	18	R	PU	Month 12
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	FRI	20	R	PU	Month 12
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	NMA	27	R	PU	Month 12
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	BOKU	26	R	PU	Month 12
D14	D8.4 Progress Report 1	8	CUNI	3	R	PU	Month 13
D15	D1.3 ARPEGE simulation at 50 km grid for the 21st century under the A1B scenario for WP2	1	CNRM	8	R,O-Data	PU	Month 18
D16	D1.4 RegCM3 simulation at 25 km grid for the 21st century under the A1B scenario for WP2	1	ICTP	8	R,O-Data	PU	Month 18
D17	D2.1 RCM simulations forced by observations	2	CUNI	35	R,O-Data	PU	Month 18
D18	D3.2 RCM output localization methods	3	BOKU	16	R	PU	Month 18
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	DMI	28	R	PU	Month 18
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	IAP	6	R	PU	Month 18
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	AUTH	17	R,O-Data	PU	Month 18
D22	D2.2 forcing files from ARPEGE for ALADIN runs	2	CNRM	8	R,O-Data	PU	Month 19
D23	D2.3 forcing files from RegCM for RegCM runs	2	ICTP	2	R,O-Data	PU	Month 19

D24	D2.4 RCM simulations forced by models	2	OMSZ	59	R,O-Data	PU	Month 30
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	IAP	22	R	PU	Month 24
D26	D4.3 Corresponding analyses of the CECILIA driving-model simulations, links between large-scale circulation patterns and extreme events	4	ETH	15	R	PU	Month 24
D27	D5.5 Present and future water demand.	5	NIHWM	2	R	PU	Month 24
D28	D5.6 Report on local air-sea interaction on the western Black Sea coast in present climate conditions.	5	NMA	6	R	PU	Month 24
D29	D6.3 Recommendations to improve effective use of water in the different production systems	6	BOKU	15	R	PU	Month 24
D30	D8.5 Progress Report 2	8	CUNI	3	R	PU	Month 25
D31	D2.5 production of the database	2	DMI	6	R,O-Data	PU	Month 33
D32	D3.4 Climate change scenarios for near future (time slice 2020-2050)	3	NMA	18	R,O-Data	PU	Month 33
D33	D3.5 Climate change scenarios for end of century (time slice 2070-2100)	3	ELU	18	R,O-Data	PU	Month 36
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	CHMI	5	R	PU	Month 36
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	IAP	2	R	PU	Month 36
D36	D6.4 International workshop and course for decision makers on the effective use of water in agricultural crop production	6	BOKU	6	R	PU	Month 30
D37	D6.5 Expected changes of occurrence and activity of pests and diseases on selected crops and forest ecosystems	6	IAP	13	R	PU	Month 36
D38	D6.6 Sensitivity analysis of the selected agriculture crops and the most vulnerable forest stands to climate change impacts	6	FRI	26	R	PU	Month 36
D39	D7.3 Key species concentrations files from higher resolution runs (10x10 km) for control run and future projection	7	CUNI	46	R,O-Data	PU	Month 33

D40	D4.4 Corresponding analyses on the CECILIA high-resolution simulations	4	NMA	43	R	PU	Month 36
D41	D4.5 Sensitivity experiments for feedback processes (land-atmosphere coupling) and their analysis	4	ICTP	12	R	PU	Month 40
D42	D2.6 analysis of scenarios, comparison with ENSEMBLES (2021-2050) and PRUDENCE (2071-2100) responses	2	CNRM	51	R	PU	Month 43
D43	D2.7 report on possible improvements in very high resolution climate simulation	2	DMI	45	R	PU	Month 43
D44	D3.6 Comparison with results of ENSEMBLES	3	CUNI	8	R	PU	Month 43
D45	D4.6 Report and/or peer-reviewed papers documenting the WP4 studies.	4	ETH	12	R	PU	Month 43
D46	D5.9 Adaptation measures proposed in the reference basins due to the climate change impact	5	NIHWM	6	R	PU	Month 43
D47	D5.10 Local air-sea interaction changes on the western Black Sea coast under different climate conditions, relevance to regional sustainable development.	5	NMA	3	R	PU	Month 43
D48	D6.7 Integrated assessment of climate change and air pollution impacts on C-cycle in agriculture and on forest ecosystems	6	ELU	13	R	PU	Month 43
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	FRI	19	R	PU	Month 43
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	CUNI	17	R	PU	Month 43
D51	D7.5 Present and future key species exceedances of the EU limits and WHO guidelines, health effects.	7	WUT	8	R	PU	Month 43
D52	D8.6 Final Plan for using and disseminating knowledge	8	1	1	R	PU	Month 43
D53	D8.7 Report on raising public participation and awareness	8	1	1	R	PU	Month 43
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	CUNI	2	R	PU	Month 43
D55	D8.9 Final Report	8	CUNI	5	R	PU	Month 45

7.6 Work packages description (full duration of project)

Assessment and provision of climate change information for downscaling and impacts

Workpackage number	1	**Start date or starting event:**			Month 1	
Activity type	**RTD/Innovation activity**					
Participant id	ICTP	CNRM	DMI	CUNI	ETH		
Person-months per participant:	15	12	4	6	2		

Objectives

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.

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);

Provision of targeted information collected and assessed from previous available projects (see above) to impact modelers involved in the other WPs for first-stream impact analysis studies.

Description of work

Two simulations for the 21st century will be completed. The first (CNRM) will use the global variable resolution model ARPEGE at 50 km grid spacing over Europe and will extend until 2100 the run presently planned for ENSEMBLES (which goes to 2050 under forcing from the A1B IPCC emission scenario) (D1.1). The second (ICTP) will use the regional climate model RegCM3 (grid spacing of 25 km) and will extend until 2100 the run presently planned for ENSEMBLES (which goes until 2050). This will be driven by ECHAM5 boundary conditions with forcing from the A1B IPCC emission scenario. (D1.2) Meteorological fields from these simulations will be provided fro use in WP2. (D1.1 and D1.2)

A number of projects have produced multi-model and multi-scale datasets of climate change over Europe. For the project PRUDENCE (just completed), different GCMs and RCMS (run mostly at 50 km grid spacing) time slice simulations were completed for the A2 and B2 IPCC scenarios. Similar but centennial scale (1950-2050 or 1950-2100) and higher resolution (25 km) simulations are planned for the ENSEMBLES project. In addition, as part of the IPCC process about 20 GCMs worldwide have been used to produce an unprecedented multi-model and multi-scenario dataset for the 20th and 21st century. The DMI has also completed a multi-decadal time slice simulation over the European region at 12 km grid spacing. All this information will be assessed (ICTP.CNRM,DMI,CUNI,ETH) to provide an evaluation of uncertainties in climate change simulations over the central-eastern European region (D1.3). ETH will focus on the assessment of terrestrial water storage.

The assessment carried out in the previous task will allow WP1 to evaluate what is the most reliable information that can be used for a first-stream application to process analysis and impact work planned for the other WPs. This targeted information will be provided to the other WPs (ICTP,DMI,CUNI).(D1.4)

Deliverables

D1.1 Month 12: Assessment of climate change information for central and eastern Europe available from previous projects (PRUDENCE, ENSEMBLES, IPCC);

D1.2 Month 12: Provision of targeted climate change information available from previous projects to other WPs for first-stream impact work.

D1.3 Month 18: Completion of ARPEGE simulation at 50 km grid spacing over Europe for the 21st century under the A1B scenario. Provision of meteorological fields to WP2.

D1.4 Month 18: Completion of RegCM3 simulation at 25 km grid spacing over Europe for the 21st century under the A1B scenario. Provision of meteorological fields to WP2.

Milestones[11] and expected result
M1.1 Month 12: Provision of data from available climate change simulations for first-stream impact work. M1.2 Month 18: Provision of driving fields from intermediate scale experiments for very fine scale targeted simulations

[11] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Regional climate modelling experiments

Workpackage number				2		Start date or starting event:			Month 1			
Activity type	RTD/Innovation activity											
Participant id	CNRM	ICTP	CUNI	DMI	CHMI	WUT	BOKU	AUTH	NMA	ELU	NIMH	OMSZ
Person-months per participant:	18	12	24	12	27	12	15	12	24	12	14	24

Objectives

This workpackage aims primarily at producing high resolution (10 km) 30-year time slices over four target areas. The model responses are to be compared with coarser results from existing simulations to assess the gain of a higher resolution. The daily data from the simulations will be put in a common database.

A secondary objective is high resolution model improvement for future scenarios.

Description of work

The first step consists of selecting the RCM and its integration domain. Two models will be used, ALADIN and RegCM. ALADIN is currently used at 10 km resolution by CHMI, NIMH and OMSZ for numerical weather prediction. RegCM is currently used at 25 km for climate studies by CUNI, NMA and ELU. In both cases one needs an adaptation to 10 km climate simulations (improved parameterizations).

Four areas will be considered by the WP: Central Europe (CHMI, CUNI), Carpathian Basin (OMSZ, ELU), Romania and Black Sea (NMA) and Bulgaria (NIMH). For the first two areas, both models will be run on the same grid.

Once the RCM and domains identified, with observed boundary conditions (ERA40) shorter runs will be performed for adaptation of parameterization for maximum benefit from the high resolution and a 30-year simulation (1961-1990) will be performed with each model for validation purpose.

The work on new parameterizations will be continued in parallel for RegCM with focus on convection (AUTH, CUNI), surface scheme (BOKU), boundary layer (WUT). The sensitivity to integration domain size will be studied (DMI). This will contribute to maintain the technical level of the partners on very high resolution climate simulation at the top.

In order to produce scenarios of the 21st century, boundary conditions from a global version of ALADIN at 50 km resolution (ARPEGE) and a European version at 25 km of RegCM will be prepared for the four above domains and three time slices: 1961-1990, 2021-2050 and 2071-2100. For the first two time slices, simulations are available at month 6, so that high resolution simulations can start at month 12. The last one is delivered at month 18 by WP1. This work is done by CNRM and ICTP.

The four time slices will be archived on a daily basis by DMI according to the standard of the previous PRUDENCE project. ENSEMBLES database is compatible with this standard. To accelerate the data delivery to the other WPs, a peer to peer exchange between RCM modelers and impact modelers will be activated.

Along with the production of time-slices, the high-resolution RCM partners (CUNI, CHMI, ELU, OMSZ, NMA and NIMH) will compare, with assistance of DMI, ICTP and CNRM who are involved in both PRUDENCE and ENSEMBLES, the mean climate features of the 2021-2050 (resp. 2071-2100) response with results from ENSEMBLES (resp. PRUDENCE). The aim of this analysis is to evaluate the gain, from an atmospheric point of view, of a 10 km resolution in producing local features. The comparison with station observation of ERA40 driven time-slices is in charge of WP3, and the validation and response of extreme events is in charge of WP4.

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 30: RCM simulations forced by models M13-M24 (CUNI, CHMI, ELU, OMSZ, NMA and NIMH)

D2.5 Month 33: production of the database M19-M26 (DMI)

D2.6 Month 43: analysis of scenarios, comparison with ENSEMBLES (2021-2050) and PRUDENCE (2071-2100) responses M25-M36 (CUNI, CHMI, ELU, OMSZ, NMA and NIMH, ICTP, DMI, CNRM)

D2.7 Month 43: report on possible improvements in very high resolution climate simulation (AUTH, BOKU, CUNI, DMI, WUT)

Milestones and expected result

M2.1 Month 6: The integration domains and RCM parameterizations are defined

M2.2 Month 18: The observation driven simulations are ready for other WPs

M2.3 Month 30: The scenarios and references RCM simulations are ready for other Wps

M2.4 Month 40: The sensitivity experiments to improved physical parameterizations are analyzed

M2.5 Month 33: The database is ready for access inside the project

M2.6 Month 43: The database is in public access and a report on the gain of high resolution in the local description of climate responses is available

Statistical downscaling, localization, validation, and scenario construction

Workpackage number	3			**Start date or starting event:**				Month 1
Activity type	**RTD/Innovation activity**							
Participant id	IAP	NMA	CUNI	CHMI	ELU	OMSZ	NIMH	BOKU
Person-months per participant:	22	18	12	9	5	8	10	8

Objectives

O3.1 Construction of statistical downscaling models for the target areas / stations and variables

O3.2 Development and implementation of techniques of localization of RCM outputs into stations

O3.3 Validation of RCM and SDS outputs

O3.4 Construction of climate change scenarios for the target areas / stations and variables

Description of work

The list of variables other than temperature and precipitation for which the SDS models should be built, RCM output localization performed, validation carried out, and scenarios constructed, will be specified based on the requirements of the impact WPs (5 to 7). The same holds for a potential enhancement of the validation criteria.

The work on statistical downscaling methods will be distributed among the institutions based on their recent expertise: IAP – MLR, ANNs, classification-based methods; CUNI – ANNs and local models in phase space; NMA – CCA, conditional weather generator; ELU – stochastic downscaling.

The techniques for the localization of RCM outputs into stations and observation up-scaling will be developed separately in indicidual institutions for different dense datasets because different geographical settings (e.g., Alpine region vs. Hungarian flatlands) may require different methodologies to be adopted.

Each participating institution will be responsible for a specific validation task: IAP – temporal and spatial characteristics, trends; NMA – links between large-scale and local surface variables; BOKU – relationships between variables in terms of evapotranspiration; CHMI – higher order statistical moments; CUNI – distribution characteristics, annual cycles and other measures of correspondence; OMSZ, ELU – evaluation of the time slice RCM runs for the Carpathian Basin using local observations; NIMH – relationships of RCM outputs with local surface variables.

The construction of climate change scenarios will be distributed among the institutions according to the SDS method employed; furthermore, IAP will utilize weather generator Met&Roll with parameters modified by GCM / RCM outputs.

Finally, the results of the project achieved for the area of central and eastern Europe will be compared with the analogous results of the ENSEMBLES project, in order to better understand the degree of the transferability of the methods.

Deliverables
D3.1 Month 12: Observed datasets for SDS models building, output localization, up-scaling, and model validation: station data in target areas and reanalysis data for SDS predictors (IAP, NMA, CHMI, BOKU, ELU)
D3.2 Month 18: RCM output localization methods (CUNI, NIMH, BOKU, CHMI, ELU)
D3.3 Month 24: 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 if possible (IAP, CUNI, NMA, NIMH, BOKU, ELU, CHMI, OMSZ)
D3.4 Month 33: Climate change scenarios for near future (time slice 2020-2050) (IAP, CUNI, NMA, ELU)
D3.5 Month 36: Climate change scenarios for end of century (time slice 2070-2100) (IAP, CUNI, NMA, ELU)
D3.6 Month 43: Comparison with results of ENSEMBLES (CUNI, IAP)

Milestones[12] and expected result
M3.1 month 6: datasets prepared, validation criteria formulated, list of variables for impacts agreed
M3.2 month 12: SDS methods developed
M3.3 month 18: RCM output localization methods developed and verified on ERA40 RCM runs
M3.4 month 24: validation and comparison of RCM and SDS models completed
M3.5 month 36: climate change scenarios for both time slices completed
M3.6 month 43: comparison with ENSEMBLES outputs finished

[12] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Climate change and extreme events

Workpackage number	4	Start date or starting event:			Month 1					
Activity type	**RTD/Innovation activity**									
Participant id	ETH	DMI	CUNI	NMA	CHMI	ELU	IAP	OMSZ	ICTP	AUTH	NIMH
Person-months per participant:	26	16	12	18	9	10	5	8	6	4	8

Objectives

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 extremes indices (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 50km down to 10 km. Assessment of the added value of 10km 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 10km 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.

Description of work

In the first stage of the project, WP4 will 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 partners, together with the selection of the sets of extreme indices (WMO, STARDEX) relevant for the analysis. (D4.1, D4.2)

A second focus of WP4 will be the assessment of the added value of 10km resolution for the simulation of extremes. First, existing daily model output (GCM, 50km, 20km as well as one set in 12km resolution) can be obtained through the data servers of the EU projects PRUDENCE and ENSEMBLES or from DMI. 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)

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. (D4.2, D4.3, D4.4, D4.5)

Studies for the whole region will be coordinated by ETH for droughts and heatwaves and by DMI for heavy precipitation; country-based studies will be performed at local institutions in collaboration with ETH and DMI. NMA will lead the analyses for Romania, ELU and OMSZ, the analyses in the Carpathian basin, and CHMI, IAP and CUNI, the analyses for the Czech republic, NIMH will perform the analyses for Bulgaria. ICTP, ETH and CUNI will collaborate on sensitivity and process studies, with contributions from NMA.

Deliverables

D4.1 Month 6: Definition of which measures and indices are to be validated, and which observational data sets are to be used for the validation of extremes. The basis will be indices of extremes as defined by the WMO and the STARDEX project. A detailed implementation plan concerning the analyses to be performed under D4.2, D4.3, D4.4, and D4.5 will be issued. (All participants)

D4.2 Month 18: Analysis of available observational datasets and of selection of pre-existing RCM data sets according to the decisions made in D4.1 (NMA, ELU, IAP, CHMI, NIMH, CUNI, ETH, DMI; AUTH for investigations of links between large-scale circulation patterns and extreme events)

D4.3 Month 24: Corresponding analyses of the CECILIA driving-model simulations. (ETH, DMI; AUTH, IAP, and NMA for investigations of links between large-scale circulation patterns and extreme events)

D4.4 Month 36: Corresponding analyses on the CECILIA high-resolution simulations:

- D4.4.a: Analysis for Czech republic (led by CHMI, IAP, and CUNI)
- D4.4.b: Analysis for Carpathian basin (led by ELU and OMSZ)
- D4.4.c: Analysis for Romanian domain (led by NMA)
- D4.4.d: Analysis for Bulgaria (led by NIMH)
- D4.4.e: Synthesis for whole region and intercomparison with pre-existing RCM data sets (led by ETH and DMI)

D4.5: Month 40: Sensitivity experiments investigating specific feedback processes (in particular land-atmosphere coupling) and their analysis (ICTP, ETH, CUNI, NMA)

D4.6 Month 43: Report and/or peer-reviewed papers documenting the WP4 studies. (All participants)

Milestones[13] and expected result

M4.1 Month 6: Decision on which measures and indices of extremes should be part of the analyses of WP4 and detailed implementation plan resulting from D4.1

M4.2 Month 43 Finished analyses of extremes based on both pre-existing and CECILIA model output

[13] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Climate change impacts in hydrology and water management

Workpackage number		5	Start date or starting event:		Month 1
Activity type	**RTD/Innovation activity**				
Participant id	NIHWM	CHMI	NMA	IAP	FRI
Person-months per participant:	42	12	9	12	9

Objectives

- Analysis based on high resolution Regional Model outputs of the climate change impact on hydrological resources in the central and eastern Europe (NIHWM, CHMI, IAP, FRI).
- Analyse of the climate change impact on the flood events (CHMI).
- Assessment of the managed water resources, demand and vulnerability and corresponding adaptation measures for present and projected climate (NIHWM, CHMI, IAP).
- 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 (IAP).
- Study of the impacts of global change signal on local climate variability of air-sea coupled modes for the western Black Sea coast. (NMA, NIHWM).

Description of work

For assessing the impact of the climate changes upon the water resources, the WATBAL model is used. This is a water balance with monthly time step model and it is combined with the Priesley-Taylor method for calculating the potential evapotranspiration. The analysed reference basins will be: Ialomiţa–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).
The rainfall-runoff models to be used for the simulations will be applied in two cases: present climate and projected climate.

Consequently, the input meteorological data (precipitation and temperature) and the rainfall-runoff model parameters will be considered as averaged values over the basin area. Such requirement can only be accomplished provided the basin area is sufficiently small (a couple of hundreds of square kilometres). In order to calibrate the models the monthly river flows over the selected period (1970-2000) will be simulated. By applying the models in the reference basins, the monthly discharge hydrographs at the outlets will be calculated.

For estimation of hydrologic impact of climate change on Dyje catchment (a part of Danube river basin with area cca 11 500 km2), the rainfall-runoff model HYDROG will be used. The objective is to find out the hydrologic impact with the view of hydrologic extremes – mainly flood events. For this purpose the model will be recalibrated according to flood events of last years (especially large floods in August 2002 and snow-melting in March 2005). Then the comparative simulations of rainfall-runoff events according to the outputs of climatic model will be done.

In order to assess the vulnerability of the water resources under the climate change conditions, monthly mean discharges series in several points of the reference basins will be necessary. These points represent the locations of water reservoirs, diversion and restitution works where the water resources - demands budgets are to be completed. The assessment of the monthly river flows in these points will be done by means of a correlation function between the station at the outlet of the reference basin and other gauging stations in the reference basins. The correlation function will be determined on the basis of the recorded data over a 30 years period at the gauging stations located in the reference basins. It is assumed that the correlation function between discharges in different points of the reference basins, determined for the current climate, maintains in the modified climatic scenario. The assessment of the vulnerability of water resources and corresponding adaptation measures will be made in the some reference basins.

An analysis of natural and man-induced variability of precipitation-runoff process and water quality in the river network will be done for a period of available water quality data (since the 1960s). Special attention will be given to water quality and eutrophication of reservoirs. On the other hand, a modelling system will be adopted to simulate precipitation-runoff processes and water quality with high temporal (day or sub-day intervals) and spatial (10- to 500-km2 segments in the catchment or 1 to 3 km longitudinal segments in reservoirs) resolution. Two major parts of the modelling system include (i) the HSPF model (http://water.usgs.gov/software/hspf.html) that was developed for simulations of hydrology and selected water quality constituents (suspended solids, phosphorus, nitrogen) in the runoff from catchment and (ii) the CE-QUAL-W2 (http://www.ce.pdx.edu/w2/) to model hydrodynamics and water quality (temperature, dissolved oxygen, algae, phosphorus, nitrogen) in longitudinal and vertical transects of stratified reservoirs. The modelling system will be calibrated, validated and then impact studies based on the results of regional climatic models will be accomplished.

The impact of climate change on hydrological-related resources of the unique environment system represented by the Black Sea coast will be investigated via an phenomenon-orientated approach. We will focus on local phenomena identified to have a major impact on regional sustainable development. Upwelling events, storm surges and spatial and temporal patterns of significant wave heights near the Romanian coast of the Black Sea will be investigated under present and future climate scenario conditions. Changes in their characteristics affect marine and terrestrial ecosystems, coastal erosion, fishery and tourism. All these phenomena imply air-sea interaction. Observational data consisting of air and sea surface temperatures, salinity and sea level from 15 hydrological and meteorological stations situated at the Romanian Black Sea coast, together with wave model results, will be used to assess the present local characteristics of air-sea interaction. Statistical models (by means of empirical orthogonal function and canonical correlation analyses) will be built to simulate the present air-sea coupling characteristics and to identify significant observational trends in meteorological and hydrological variables (air and sea surface temperature, sea level, salinity, and wave heights). In a second phase, the statistical models together with the experiment results from regional climate models will be used to assess changes in frequency occurrence and magnitude of the above-mentioned local phenomena on the western Black Sea coast under different climate conditions.

Deliverables
D 5.1 Month 6: Report concerning a brief description of the rainfall-runoff models and of the reference basins, a revision of flood events from the analyze period, the input data (precipitation, measured discharges in stream flows, outflows from reservoirs, snow cover, temperature, etc.), the schematization of the reference basins.
D 5.2 Month 12: Report on the calibration of the monthly river flows over the selected period (1970-2000) and rainfall-runoff models according to the flood events over the same period.
D 5.3 Month 12: Report with analysis of natural conditions, climate, hydrology, development of land use, surface water quality, and water management during the period from the 1960s, i.e. start of intensification of agriculture and large-scale development of water supply systems, to the present.
D 5.4 Month 18: Report on the description, calibration, and sensitivity and uncertainty analysis of the atmosphere-river network-reservoir modelling system used for simulations of hydrology and water quality and on simulation of monthly river flow considering climate changes and the comparison of results,
D 5.5 Month 24: Report concerning the present and the future water demand.
D 5.6 Month 24: Report on local air-sea interaction on the western Black Sea coast in present climate conditions.
D 5.7 Month 36: Report concerning the sensitivity of reference basins using the balance between the demand and water resources and of flood events within the present and future conditions with or without climate change based on outputs from climate scenarios simulations
D 5.8 Month 36: Report on 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.
D 5.9 Month 43: Report concerning the adaptation measures proposed in the reference basins due to the climate change impact
D 5.10 Month 43: Report on local air-sea interaction changes on the western Black Sea coast under different climate conditions and their relevance to regional sustainable development.

Milestones[14] and expected result

M5.1 Month 12:
- 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.

M5.2 Month 24:
- 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.

M5.3 Month 36:
- 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.

[14] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Climate change impacts on agriculture and forestry sectors

Workpackage number	6		**Start date or starting event:**			Month 1	
Workpackage title	**RTD/Innovation activity**						
Participant id	FRI	IAP	ELU	BOKU	NMA	CHMI	WUT	NIMH
Person-months per participant:	28	24	8	18	14	9	12	14

Objectives

This workpackage will analyze the impacts on agriculture and forestry sectors. 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). The workpackage will study the regional climate change impacts with the main focus on:

- 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.

Description of work

The outputs from WP1-4 and WP7 will be applied as input parameters (climate variables, air pollution levels/loads) for the analyses and modelling calculations in this part of the impact study.

There will be selected 3 representative regions with different climate conditions and land-use systems:
1. *Semi-arid agricultural region with similar crop production systems in lowlands (NW part of Austria, SE part of the Czech republic, SW part of Slovakia and NW part of Hungary)*

Appropriate simulation tools for calculating crop yield and water balance, water demand (e.g. for irrigation) will be selected, calibrated and validated (models such as CERES, STICS, SWAP, CROSWAP, BIOME-BGC etc.). The simulation tools may include drought indices for detection of drought damage potential under various climate scenarios as well as water balance models and crop yield models for detailed analysis of crop water availability and management options under the various conditions and scenarios. Judgement of changes of agroclimatic characteristics, especially temperature sums, the onset time of significant phenological characteristics of agricultural plants, pests and diseaeses. GIS will be used to visualisize regional effects on water balance and drought damage potential under climate change scenarios. We assume that activities will be focused on main crops (winter wheat, spring barley, maize) and grasslands. Also the spatial analyses will be applied for the evaluation of climate change impacts on some important pests and diseases (weather depending). Special case study related to C-cycle change will be carried out using the BIOME-BGC model for agroecosystems.

2. *Arid (semi-arid) agricultural region with similar crop production systems in SE part of Europe (Romania-Bulgaria)*

Appropriate simulation tools for calculating crop yield and water balance, water demand for wheat and maize crops, will be selected and calibrated (models such as CERES, HYDRUS1D, WOFOST etc.). The simulation tools may include drought indices for detection of drought damage potential and soil water availability under various climate scenarios. The simulations will be run for pilot stations, and then for additional agrometeorological stations for regional characterization of crop water use.

3. *Mountain regions with dominant forest stands (S part of Poland, Central part of Slovakia, N part of Hungary)*

The appropriate models (e.g.SYBILA, SILVA) will be used for the assessment of climate change impacts on tree growth (main tree species – Norway spruce, European beech and Oak sp.) under the different climate scenarios for the selected regions under current management systems. Also the spatial analyses will be applied for the evaluation of climate change impacts on some important pests and diseases (weather depending). Estimation of the critical thresholds (air pollution) (e.g. VSD, PROFILE models) as well as selected bioclimatological indices for main tree species will be used for the integrated assessment of climate change and air pollution sensitivity analysis of the most vulnerable forest stands. GIS will be used to visualisize regional effects on CC impacts on forests (vulnerability) under climate scenarios and management options. Special case study related to C-cycle change will be carried out using the BIOME-BGC model for forest ecosystems.

Based on the results from the modelling simulations some conclusions for land management (agriculture and forestry) will be defined as potential adaptation options according to IPCC recommendations

Deliverables

D 6.1 Month 6: Report about the results of the crop yield and forest tree growth changes influenced by climate change effects, regional conditions and management systems (IAP, BOKU, FRI, CHMI, NMA, ELU, NIMH).

D 6.2 Month 12: Report about the 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).

D 6.3 Month 24 Recommendations to improve effective use of water in the different production systems (BOKU, IAP).

D 6.4 Month 30: International workshop and course for decision makers to learn more about the effective use of water in agricultural crop production (BOKU, IAP).

D 6.5 Month 36: Report about the expected changes of occurrence and activity of pests and diseases on selected crops and forest ecosystems (IAP, FRI, CHMI).

D 6.6 Month 36: Report about the sensitivity analysis of the selected agriculture crops and the most vulnerable forest stands to climate change impacts (FRI, IAP, BOKU, CHMI, WUT).

D 6.7 Month 43: Report about the integrated assessment of climate change and air pollution impacts on C-cycle in agriculture and forest ecosystems (FRI, WUT, ELU).

D 6.8 Month 43: Recommendations and development of management options for an improved land use systems in agricultural crop production and forest management under the regional climate change scenarios (FRI, IAP, BOKU, NMA, CHMI, NIMH).

Milestones[15] and expected result

M6.1 Month 6: Selection of agricultural and forest regions, Data base on historical data and other model input data, Preparation of the GIS tools

M6.2 Month 12: Calibration and validation process of the selected models (water balance, drought indices and growth) for the main selected crops, crop rotations and forest ecosystems.

M6.3 Month 24: 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.

M6.4 Month 36: 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.

M6.5 Month 43: 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

[15] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Climate change impacts on air quality and health

Workpackage number	7	**Start date or starting event:**			Month 1
Activity type	**RTD/Innovation activity**				
Participant id	WUT	BOKU	CUNI	NIMH	AUTH	CHMI
Person-months per participant:	26	18	18	14	26	12

Objectives

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.

Description of work

To exploit the sensitivity of air-pollution levels to potential climate change, RCM simulations for future projections and for the control period will be used to drive offline AQM. The following AQM will be applied: open-source models: CHIMERE, CAMx and CALPUFF as well as own models: POLSOX-II (WUT) and SMOG (CUNI). These AQM will be adapted to meteorological input data coming from RCM simulations made by RegCM and ALADIN-Climat RCMs. We will model the interaction between climate and air quality by predictions of air pollution levels in the selected target regions on the fine scale of the RCM's (10 km).

Long range transport to the target regions will be taken into account by performing one calculation covering the whole of Europe, driven by RCM with a grid resolution 50x50 km. With respect to the amount of computing time and storage requirement, only 10 years will be calculated for each of the four prospected time intervals. The boundary conditions of this continental grid controlled by the global background concentrations have to be estimated. The output of the European runs will serve as boundary condition for runs on the fine grid scale of the RCM's.

Furthermore these simulations will be used to constrain nested higher resolution runs (10x10 km) for a smaller domain focusing in Central-Eastern Europe both for present and future potential climate. The key species to be simulated will be ozone, sulphur and nitrogen species as well as PM, which have a central role in tropospheric chemistry as well as the strong health impacts. Emphasis will be given to present and future key species exceedances of the EU limits for the protection of human health, vegetation and ecosystems as well as WHO guidelines. Two important aspects which will be considered with caution are a) the emission inventories to be used to constrain the air-quality models for the future projections and b) the chemical boundary conditions for the regional domain. Basis for the applied emission inventories will be the EMEP data base, providing emissions of all main pollutants for the years 1970 to 1995 (every 5 years), from 1996 every year and for projections for 2010 and 2020. In addition local data bases will be used for downscaling EMEP data. As we are assuming that the results of these studies should not be considered as predictions of future air quality levels associated with climate change but rather demonstrate the sensitivity of atmospheric air pollutants to changes in specific meteorological variables, we will keep constant important constraints such as future emissions or chemical boundaries of the regional domain.

Deliverables

D 7.1 Month 12: Coupling of the AQM's to the RCM's. Development of the pre-processors to convert RCM-output to AQM-input.

D 7.2 Month 18: Key species concentrations files from the European runs for 4 * 10 years with 50 km resolution based on CBM-IV chemistry with sulphur (BOKU, AUTH). Analysis of the output of the offline chemistry AQMs for future projections and for the control period.

D 7.3 Month 33: Key species concentrations files from higher resolution runs (10x10 km) for specific smaller domains in Central Eastern Europe for control run and future projection (WUT, CUNI-CHMI, BOKU, AUTH).

D 7.4 Month 43: Analysis and evaluation of the results, comparison of the higher resolution runs (10x10) with the lower resolution runs (50x50) for the specific domain.
D 7.5 Month 43: Present and future key species exceedances of the EU limits and WHO guidelines, health effects (WUT, BOKU, CUNI, CHMI, AUTH).

Milestones[16] and expected result

M7.1 Month 12: Selection of the air-pollution episodes to be simulated from the offline and online chemistry AQMs.

M7.2 Month 18: Simulations of the offline chemistry model CHIMERE and/or CAMx driven by RCM for Europe with 50x50 grid resolution.

M7.3 Month 24: Results from the comparison of key species levels simulated by the offline and online regional AQMs.

M7.4 Month 28: Simulations of the offline AQMs driven by RCM for a specific smaller domains in Central Eastern Europe with 10 x 10 grid resolution.

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.

M7.6 Month 33: 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.

M7.7 Month 36: 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.

[16] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Project management

Workpackage number	8		**Start date or starting event:**			Month 1		
Activity type	**Management activity**							
Participant id	CUNI							
Person-months per participant:	27							

Objectives

Coordination of the works on the project

- 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
- providing the information based on project results to endusers, policy and decision makers, local authorities etc.

Finalizing the reports, writing of the final report

Description of work

For details, see Sec.6.1

Deliverables

D 8.1 Month 1 Project web site established

D 8.2 Month 4 Project Presentation

D 8.3 Month 6 Workshop with potential endusers, stakeholders or decisionmakers

D 8.4 Month 13 Progress Report 1

D 8.5 Month 25 Progress Report 2

D 8.6 Month 43 Final Plan for using and disseminating knowledge

D 8.7 Month 43 Report on raising public participation and awareness

D 8.8 Month 43 Final workshop, information and outputs for endusers, policy and decision makers, local authorities etc. (done as well in connection to project meetings in individual targeted countries throughout the project period)

D 8.9 Month 45 Final Report

Milestones[17] and expected result

[17] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

STREP Project Effort Form - Full duration of project
person-months for activities in which partners are involved

Project acronym - CECILIA

	CUNI	ICTP	CNRM	DMI	AUTH	CHMI	IAP	ETH	BOKU	NMA	NIMH	NIHWM	OMSZ	FRI	WUT	ELU	TOTAL PARTNERS
RTD/innovation activities																	
WP1 (Giorgi)	6	15	12	4				2									39
WP2 (Deque)	24	12	18	12	12	27			15	24	14		24		12	12	206
WP3 (Huth)	12					9	22		8	18	10		8			5	92
WP4 (Seneviratne)	12	6		16	4	9	5	26		18	8		8			10	122
WP5 (Mic)						12	12			9		42		9			84
WP6 (Hlásný)						9	24		18	14	14			28	12	8	127
WP7 (Juda-Rezler)	18				26	12			18		14				26		114
Total research	**72**	**33**	**30**	**32**	**42**	**78**	**63**	**28**	**59**	**83**	**60**	**42**	**40**	**37**	**50**	**35**	**784**
Demonstration activities																	
Total demonstration																	
Consortium management activities																	
WP8 Project coordination (Halenka)	27																27
Total consortium management	**27**																**27**
TOTAL ACTIVITIES	**99**	**33**	**30**	**32**	**42**	**78**	**63**	**28**	**59**	**83**	**60**	**42**	**40**	**37**	**50**	**35**	**811**

8 Project resources and budget overview

8.1 Efforts for the full duration of the project

From the figures in STREP Project Effort Form it can be seen the consorcium has achieved critical mass of personnel resources, the composition of the consorcium is broad and interdisciplinary as necessary for such a study. There is firm background provided by the consorcium in regional climate modelling (WP2, about 26% of RTD activities PM of the project), accompanied with WP3 and 4 creating altogether more than a half of the RTD capacity. On the other hand, those are preparatory WPs for further impact studies, therefore underestimation of them could lead finally to the failure of some project tasks. Moreover, as mentioned before, we are providing rather tests and examples of the potential climate change impact studies based on very high resolution regional climate modelling, full coverage of indepth impact studies of all sectors is behind the framework of STREP, both of the effort and consequently the costs, but mainly in number of partners.

8.2 Overall budget for the full duration of the project

With respect to the main objective and a broad involving of the teams to meet the demand of interdisciplinarity of the topic the overall financial plan for the project is adequate. Most of the partners provide their own additional capacity and human resources for the project, some of them even cover significant part of computation costs. There is supposed higher amount of funds for improvement technical resources in CEE partners mainly for running the simulations and data storage, both as durable and consumables. It should be mentioned that due to rather low personnel costs (per month salary) the funds from overhead cannot cover all the expenses. Budget overview is summarized in Table 2 , CPF forms A3.1 and A3.2 are included as Tables 3 and 4, respectively.

8.3 Management level description of resources and budget

Table below displays the costs planned for individual partners and in total for some basic categories as personnel costs, funs for durable equipment, consumables, traveling and other costs. Following the cost model there are overheads planned in addition to the direct eligible costs, resulting contribution from EC is based on the cost model, either. With respect to the target area of the project the stress in PM is on countries of Central and Eastern Europe, however, in personnel expenditures due to much higher level of salaries it is not seen. The necessary improvement of technologies and equipment for the partners from targeted area requires higher costs for durable equipment and consumables, moreover, this cannot be covered so much from overheads as due to much lower personnel the overheads does not provide so much for these partners.

Mainly planned durable equipment will improve the capacity of the partners from Central and Eastern Europe significantly. The concentration of these resources for the project is essential and useful, as individual partners thus will have the possibility to share know-how available already in the field of regional climate modeling and to apply it in their conditions for their purposes. Finally, it will provide overall picture of climate change impact potential in this part of Europe.

Besides the equipment bought from the project funds it is supposed the partners are using their own resources as well. There are supercomputing capacity or PC clusters available at some of the partners which means quite significant additional value where involved at AC cost model partners (CHMI), even in FC model probably not all computation costs will be included into the project budget. Similarly, the other infrastructure and equipment of the partners will be available. It will be matter of the management to use the resources efficiently for the project tasks, even maybe to share between some partners when necessary. This will be crucial point as for data availability and sharing, the huge amount of local model results could be better preprocessed locally instead of their transfer to the user side. For sharing the computing power, there is good example from Greece with their HellasGrid computing system integrating computers across the Greece.

TABLES AND TEXT DETAILING FINANCES WERE ERASED FROM THIS PUBLIC VERSION OF THE DOCUMENT

9 Ethical issues

No ethical issues

10 Other issues (optional)

10.1 Gender issues

There are no gender issues associated with the subject of the CECILIA proposal. The topic of climate change impacts is in central and eastern Europe equally relevant for women and men. The research planned in this STREP addresses the needs of both genders equally, it is neutral, and its results are important for the general society, independent of gender. Hence there are no gender issues involved in the field and the research of CECILIA. In many teams of the consortium many women are involved and some of them are Partner Leaders as well as in the positions of WP Leaders there are 3 women from 7 .

10.2 Policy issues

As mentioned in B.3.1 the CECILIA project shall provide a contribution to the improvement of the scientific basis for implementation of the policy to reduce emissions of greenhouse gases. The CECILIA team is prepared to provide the experience and knowledge based on the analysis of local and regional impacts of climate change to contribute to the negotiations in the post Kyoto process and in regulations to mitigate the possible consequencies of climate change as well as to the definition of future EU agricultural and energy policies. For this purposes, reliable information and results from the project shall be available for policymakers and local authorities.

Another significant aspect in EU policy is promoting the climate change impact issues to the area of former Eastern Block. This proposal already has become to be a platform for spreading the contacts between the climate change scientists from the targeted area and western part of Europe and, if accepted, it will start the real extensive collaboration between older part and “newcomers” in the climate change research in EU and thus it will help to bridge the previous gaps. Moreover, dissemination of the results across the targeted area to other institutes, universities, as well as local authorities and policy makers from non participating countries shall even make the spreading of these policy relevant information more efficient. The members of the CECILIA team are ready to provide the necessary concultancy and materials for better application of knowledge obtained.

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Appendix A - Consortium description

A.1. Participants and consortium:

A.1.1. Charles University in Prague (CUNI)

The team from Charles University in Prague have expertise in a range of climate-related research topics including regional climate modelling, parameterizations and statistical evaluation of the reliability, sensitivity and uncertainty of model results comparing both with grided climatology and station data. CUNI has participated and coordinated in several EU, international and national projects, respectively. It has provided numerous consultations to local and national governmental authorities and organizations in its field of expertise. In relation to this proposal mainly participation in FP6 Project ENSEMBLES and QUANTIFY will provide benefits for the progress in this study.

In this project, CUNI will act as the Project Coordinator and will be responsible for the management and the overall administration of the project (WP8). With broad experience in international projects, CUNI will ensure the necessary expertise required in the implementation of the project. Moreover, CUNI will actively participate in most WP's, with emphasis on WP2 (RegCM simulations), WP3 (localization of model outputs), WP4 (impacts on extremes) and WP7 (impacts on air quality).

Key persons:
RNDr. Tomas Halenka, CSc., born 1959, Hlinsko, Czech Republic. RNDr. degree in Meteorology (NWP), Charles University in Prague, 1984, postgraduate study, researcher on Dept. of Meteorology and Geophysics, CSc. Degree in Meteorology, 1994, assistant professor on Dept. of Meteorology and Environment Protection, Fac. of Math. and Physics, Charles University, 2006 – Associate Professor. Experience and expertise in numerical modelling of the atmosphere, regional climate modelling, dynamic meteorology, climate dynamics and global circulation, stratosphere, ozone, lectures on NWP, Dynamic Meteorology, Meteorological Instruments and Observation, Dynamics of the System Ocean-Atmosphere, supervisor of many diploma and doctoral student. Participation and coordination in several EU, international and national projects, respectively, project FP6 EC ENSEMBLES, member of steering committee in project FP6 EC QUANTIFY, project FP5 EC SOLICE. Regular associate of ICTP, chairman of Prague local chapter and Scientific Secretary of Czech Meteorological Society, Vice-President and Treasurer of European Meteorological Society, chairman of educational committee of EMS. He is supposed to coordinate this project.

doc.RNDr. Jaroslava Kalvová, CSc. (associate professor), long expertise and research in climate change, climate variability, impacts of climate change, lectures on climatology, statistics. Participation and coordination in several EU, international (Country Study) and national projects, respectively, project FP6 EC ENSEMBLES, project FP5 EC SOLICE. Doc.RNDr. Josef Brechler, CSc., (associate professor), expertise in emission data analysis, air-pollution modelling, development, Prof.RNDr. Jan Bednář, CSc., air quality studies, Dr. Jiří Mikšovský (assistant professor), analysis of nonlinear time series, predictability, deterministic chaos, and doctoral students

Selected recent relevant publications:

Halenka, T.: On the trends in global circulation in 50 years of NCEP/NCAR reanalyses. Physics and Chemistry of the Earth. Part B, Hydrology, Oceans and Atmosphere, 27, č. 6-8, 2002, 415-426

Bednář, J., J. Brechler, T. Halenka, J. Kopáček: Modelling of summer photochemical smog in the Prague region, Physics and Chemistry of the Earth (B), 2001, 26, 129-136.

Bednář, J., J. Brechler, T. Halenka: Photochemical smog modelling in Prague. International Journal on Environment and Air Pollution, roč. 16, č. 1-6, 2002, 264-273.

Koppen climate types in observed and simulated climates, Kalvová, J., T. Halenka, K. Bezpalcová, I. Nemešová: Stud. Geophys. Geod., 47, 2003, 185-202.

On the integrability of limited-area numerical weather prediction model ALADIN over extended time periods. Huth, R., Mládek, R., Metelka, L., Sedlák, P., Huthová, Z., Kliegrová, S., Kyselý, J., Pokorná, L., Janoušek, M., Halenka, T.,Studia geoph. geod., 47, 2003, 863-873.

A.1.2. The Abdus Salam International Centre for Theoretical Physics (ICTP)

Founded in 1964 by Abdus Salam (Nobel Laureate), the ICTP operates under the aegis of two United Nations Agencies: UNESCO (United Nations organization for Education, Science and Culture) and IAEA (International Atomic Energy Agency), and is regularised by a seat agreement with the Government of Italy, which provides the major part of the Centre's funding. The main aim of the ICTP is to foster the growth of advanced studies and research in physical and mathematical sciences, especially in developing countries. The Physics of Weather and Climate (PWC) Group was established in 1998 and conducts research on regional climate modeling, anthropogenic climate change, natural climate variability, chemistry-climate interactions and biosphere-atmosphere interactions. In particular, the PWC group maintains and develops a state-of-the-art regional climate model (RegCM). This model was developed during the last decade and has been used for a wide variety of applications, from paleo climate to future climate simulations at the regional scale. The RegCM has been applied to a wide range of regions in the globe (Europe and the mediterranean Basin, United States, Sub-Saharan Africa, Central, East and South Asia, South America) and has been run at horizontal grid intervals of 10-100 km. It has capability of interactive coupling to an aerosol model and to a one dimensional lake model. The RegCM is currently used by a wide range of users, including many from developing countries. Filippo Giorgi and Jeremy Pal have worked on regional climate modelling for over 10 years and are the main developers of different versions of the RegCM. They coordinate a network of RegCM model users (the RegCNET) which includes several participants of this project. The ICTP has been directly involved in previous European projects such as PRUDENCE and ENSEMBLES.

The role of the ICTP within the project will be in the coordination of the collection and analysis of climate change scenario results from relevant previous projects (PRUDENCE, ENSEMBLES) (WP1) and in providing scientific consultation for the development and adaptation of a very fine scale (grid spacing of 10 km) version of the RegCM for use by other partners in the project. (WP2)

Key persons:

Filippo Giorgi, senior scientist at ICTP has pioneered regional climate modelling in the late eighties and has been a leading scientist in this field since then. He has been at ICTP since 1998, after being a scientist at NCAR for about 13 years. Giorgi has authored or co-authored over 120 peer-reviewed publications and has been involved in EU-funded projects focusing on regional climate modelling and regional climate change (PRUDENCE, ENSEMBLES).

Jeremy S. Pal joined the ICTP in 2001 as a tenure track scientist after obtaining a PhD from MIT. He is the main developer of the latest version of the RegCM (RegCM3) and has published extensively in regional climate modelling and land-atmosphere interactions.

Xunqiang Bi has been a support scientist at ICTP since 1999 and is in charge of the maintenance and distribution of the RegCM3 code. As such he will provide computational support to the project.

Selected recent relevant publications:

Giorgi, F., Francisco, R., 2000: Evaluating uncertainties in the prediction of regional climate change. Geophys. Res. Lett., 27, 1295-1298.

Giorgi, F., Bi, X., Pal, J.S., 2004: Mean, interannual variability and trends in a regional climate change experiment over Europe. I. Present-day climate (1961-1990). Clim. Dyn., 22, 733-756.

Giorgi, F., Bi, X., Pal, J., 2004: Mean, interannual variability and trends in a regional climate change experiment over Europe. II: climate change scenarios (2071–2100). Clim. Dyn., 23, 839-858.

Pal, J. S., F. Giorgi, and X. Bi, 2004: Consistency of recent European summer precipitation trends and extremes with future regional climate projections. Geophysical Research Letters, 31, L13202, doi:10.1029/2004GL019836.

A.1.3. Météo-France (CNRM)

The Centre National de Recherches Météorologiques (CNRM) of the French meteorological service (Météo-France) is the department responsible for conducting the largest part of the meteorological research activities, and for coordinating research/development undertakings conducted within other departments. Primarily oriented towards the needs of public utility in the domain of meteorology, the research actions encompass the atmosphere, extending to, and including, closely related fields and boundaries, such as stratospheric ozone chemistry, upper ocean, physics and dynamics of the snow cover, surface hydrology etc. To carry out its missions, CNRM hosts approximately 225 permanent positions (one third being research scientists). The research is conducted in close cooperation, at the national level with atmospheric laboratories from other institutions and agencies (Universities, National Centre for Scientific Research CNRS -of which CNRM is also the “ GAME ” joint laboratory) and, at the international level, with many different foreign research laboratories. This collaboration is realized through participation in multidisciplinary research programmes such as IGBP, WCRP, and French national programmes. CNRM also tightly cooperates with the European Center for Medium-Range Weather Forecasts (ARPEGE-IFS model) and with other European meteorological services (ALADIN network). CNRM has been involved in EU-funded projects focusing on seasonal predictability (PROVOST, DEMETER) regional climate modelling (RACCS, MERCURE, PRUDENCE) or present climate simulation (HIRETYCS, POTENTIALS). CNRM is now involved in the ENSEMBLES project both in the regional modelling and seasonal forecast side.

The role of CNRM in the project will be to provide expertise in the use of PRUDENCE scenarios data (WP1) and to produce and prepare boundary conditions from ARPEGE at 50 km resolution for ALADIN at 10 km resolution (WP2). The expertise obtained in ENSEMBLES about the use of ALADIN in climate mode (ALADIN is primarily a short-range forecast model) will be made available to partners using this model (WP2).

Key persons:

Michel Déqué, senior scientist, has been working at the research Centre of Météo-France since 1979. He has a more than 25 year experience in climate simulation and has been head of the research group developing the climate version of ARPEGE-IFS for almost 15 years. He has been involved in EU-funded projects focusing on seasonal predictability (PROVOST, DEMETER) regional climate modelling (RACCS, MERCURE, PRUDENCE) or present climate simulation (HIRETYCS, POTENTIALS). He is involved in the ENSEMBLES project both in the regional modelling and seasonal forecast side. He will be assisted by Samuel Somot, permanent researcher at CNRM, who has just defended a Ph-D thesis on regional coupled modelling in the Mediterranean area, and is responsible for the development of the regional model ALADIN-Climate. Alain Braun, computer scientist in the climate group since its creation, will manage the data transfer.

Selected recent relevant publications:

Clark, R.T. and Déqué, M., 2003: Conditional probability seasonal predictions of precipitation. Quart. J. Roy. Meteor. Soc., 129, 1-15.

Terray L., Demory, M.E., Déqué, M. , de Coetlogon, G. and Maisonnave, E., 2004: Simulation of late twenty-first century changes in wintertime atmospheric circulation over Europe due to anthropogenic causes. Journal of Climate, 17, 4630-4635

Déqué, M., Jones, R.G., Wild, M., Giorgi, F., Christensen, J.H., Hassell, D.C., Vidale, P.L., Rockel, B., Jacob, D., Kjellström, E., de Castro, M., Kucharski, F., van den Hurk, B., 2005: Global high resolution versus Limited Area Model climate change projections over Europe: quantifying confidence level from PRUDENCE results. Climate Dynamics, 25, 653-670 .

Guérémy, J.F., Déqué, M., Braun and Piedelievre, J.P., 2005: Actual and potential skill of seasonal predictions using the CNRM contribution to DEMETER: coupled versus uncoupled model. Tellus, 57A, 308-319

Guldberg, A., Kaas, E., Déqué, M., Yang, S. and Vester Thorsen, S., 2005: Reduction of systematic errors by empirical model correction: impact on seasonal prediction skill. Tellus, 57A, 575-588

A.1.4. The Danish Meteorological Institute (DMI)

DMI is the national meteorological service for Denmark, Greenland and the Faroe Islands, with extensive research interests in numerical weather prediction and climate variability on monthly to centennial time scales. The research department at DMI has about 70 employees and is organised in four divisions. The Climate Research Division, which is going to participate in the present project, currently consists of 8 scientists and 2 Ph.D. students. It has been involved in several international research projects on global and regional climate modelling relevant to the CECILIA project. Mostly these projects have been funded by the EU. Examples of these are: "Regionalization of Anthropogenic Climate Change", RACCS; TUNDRA; "Global implications of Arctic climate processes and feedbacks", GLIMPSE; "Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects", PRUDENCE: and the ENSEMBLES project.

The Climate Research Division at DMI has extensive experience in climate modelling. This includes geophysical applications (climatic sensitivity to external forcing, natural climate variability and seasonal prediction) as well as model development. The regional climate model HIRHAM which has been developed jointly by DMI and the Max Planck Institute for Meteorology in Hamburg has been extensively employed in resolutions down to 12km. DMI is also involved in the regional model inter-comparison study PIRCS, under which simulations using the Hadley Centre GCM boundary conditions for present day climate and climate change simulations over USA have been conducted.

Key persons:

Dr. Ole Bøssing Christensen (senior scientist) has worked at DMI since 1993 and holds a Ph.D. in physics. He has worked with regional climate modelling, data analysis and data manipulation as well as analyses of changes in extreme weather. He has been involved in several EU projects concerned with regional climate modelling, such as RACCS, PRUDENCE, and ENSEMBLES, and is a member of the BALTEX scientific steering group and the WISE international working group about extremes under the WCRP.

Dr. Jens Hesselbjerg Christensen (senior scientist) has been employed at DMI since 1990 after taking his Ph.D. the same year. He started the regional climate modelling at DMI and participated in the construction and development of the HIRHAM model. He has been the principal investigator for the DMI contribution to several international projects. He was a lead author on the IPCC 3rd assessment report (WGI), Chapter 10 "Regional Climate Information –Evaluation and Projections", and a contributing author to the ACIA report, Chapter 4 " Future climate change: Modeling and Scenarios for the Arctic region" and he is currently one of the two co-ordinating lead authors on the IPCC 4th assessment report (WGI), Chapter 11 “Regional Projections”. Presently, he serves as a member of the CliC numerical experimentation group under the World Climate Research Program (WCRP). He has been actively involved in several EU projects, such as ESOP, ESOP2, TUNDRA, GLIMPSE and PRUDENCE (coordinator), one of the key leading scientist in the ENSEMBLES.

Selected recent relevant publications:

Christensen, O. B., and J. H. Christensen, 2004: Intensification of extreme European summer precipitation in a warmer climate. Global and Planetary Change, 44, 107-117

Christensen, J.H. and O.B. Christensen, 2003: Severe Summer Flooding in Europe, Nature, 421, 805-806.

Christensen, O. B., J. H. Christensen, and M. Botzet, 2001: Heavy Precipitation Occurrence in Scandinavia Investigated with a Regional Climate Model. In M. Beniston (ed.): Implications of climatic change for the hydrological cycle and for water management, Advances in Global Change Research, Kluwer Academic Publishers.

Christensen J.H., J. Räisänen, T. Iversen, D. Bjørge, O.B. Christensen, and M. Rummukainen, 2001: A synthesis of regional climate change simulations -A Scandinavian perspective. Geoph. Res. Lett., 28, 1003-1006.

Pan, Z., J.H. Christensen, R.W. Arritt, W.J. Gutowski, E.S. Takle, F. Otieno, 2001: Evaluation of uncertainties in regional climate change simulations. J. Geophys. Res. 106, 17735-17752.

A.1.5. Laboratory of Atmospheric Physics, University of Thessaloniki, Greece (AUTH)

The main experience and expertise of the team of AUTH (Laboratory of Atmospheric Physics) is in air pollution research at the regional and local level, research in the physics and meteorology of the ozone layer and basic research in Global Change. Specific tasks are covered in research on UV-A, UV-B and tropospheric ozone, as well as development and operation of LIDAR systems for aerosol and ozone monitoring in the free troposphere, ozonesondes and total ozone continuous monitoring, as well as long-path measurements of trace gases with DOAS, by operation of the WMO/GO3OS Northern Hemisphere Ozone Mapping Centre since 1991 and by operation of the National Network for Ozone and Solar UV Radiation (which is part of GAW). In addition, LAP has provided numerous consultations to local, national and international governmental authorities and organizations in its field of expertise. It has participated in numerous EU, international and national projects.

Key persons:

Dr. Dimitris Melas is an associate professor at the University of Thessaloniki. He has experience in air pollution, numerical modelling, data analysis and coupling between model results and observations. Previous research activities, related to the objectives of the present proposal, focus on numerical simulations of air pollution and on the determination of the origin of the measured air masses through the calculation of back trajectories. He has published more than 40 papers in international journals with peer review .

Dr. Kleareti Tourpali is a lecturer at LAP since 2004. She has more than 15 years experience in research on climate issues related to ozone changes. Her recent research interests, where she has more than 5 years experience, lie in the field of studying the response of stratosphere, troposphere and the earth's climate to natural variability such as the solar cycle, using a fully interactive coupled chemistry-GCM.

Dr. Prodromos Zanis has around 10 years of experience on basic and applied research on atmospheric physics and chemistry with emphasis on tropospheric and stratospheric ozone and air pollutants. He is specialised on the performance of peroxy radical measurements, data analysis and chemical box modelling, aiming on the evaluation of the potential of in-situ photochemical ozone production in the free troposphere. He participated in three intensive field experiments at the Jungfraujoch in the Swiss Alps, in a number of EU-projects and in other Swiss and Greek national competitive research projects. Since 2003, he has a fixed research position at the Research Centre for Atmospheric Physics and Climatology, Academy of Athens. He has more than 25 publications in peer-reviewed scientific journals.

Selected recent relevant publications:

Melas D., Abbate G., Haralampopoulos D. and Kelesidis A. (2000) Estimation of meteorological parameters for air quality management: Coupling of sodar data with simple numerical models. J. of Applied Meteorology 39, 509-515.

Tourpali, K., C. J. E. Schuurmans, R. van Dorland, B. Steil, C. Brühl, and E. Manzini, "Solar cycle modulation of the Arctic Oscillation in a chemistry-climate model", Geophys. Res. Lett., 32, L17803, doi:10.1029/2005GL023509, 2005

Zanis P., K. Kourtidis, B. Rappenglueck, D. Balis, D. Melas, C. Zerefos, R. Schmitt, S. Rapsomanikis, and P. Fabian. A case study on the link between surface ozone photochemistry and total ozone during the PAURII experiment at Crete – Comparison of observations with box model calculations. Journal of Geophysical Research, 10.1029/2000JD000137, 2002.

A.1.6. Czech Hydrometeorological Institute (CHMI)

The Czech Hydromoteorological Institute (CHMI) is a central state institute of the Czech Republic governed by Ministry of Environment. The present-day organization of the Institute is based on three independent disciplines covered by the departments of meteorology, hydrology and air quality protection, connected in the central body with seven regional offices providing comprehensive services along all of the Institute's activities. The activities cover areas from observations, measurements and monitoring through issuing expert opinions to providing forecasts and warnings. CHMI carries out tasks at both national and international levels, such as the National Climate Programme of the Czech Republic. CHMI hosted LACE activity for NWP for Central Europe using ALADIN and providing supercomputer resources.

Relevant to this proposal we are involved in FP6 project ENSEMBLES, two local projects dealing with the development of regional climate model for the Central Europe and other projects dealing with estimate of climate change impact in Czech Republic.

Our participation is founded on the further development of regional climate model with high resolution based on ALADIN NWP model and its realization together with CUNI and MeteoFrance, running the necessary experiments etc (WP2). The participation in validation experiments and validation work is supposed as well (WP3). In WP5, CHMI will contribute to studies of climate change impact on hydrological cycle and case studies of hydrological impacts with concentration on extreme flood events by means of mathematical models (WATBAL, HYDROG) in Dyje catchments (cca 11.500 km2). In WP6 CHMI will study climate change impacts on agriculture and landscape, in WP7 impacts on air quality. RNDr. Ing. Jaroslav Rožnovský, CSc., experience in climate change impacts studies, data analysis, climate change impacts on agriculture.

Key persons:

Mgr. Petr Štěpánek, PhD in climatology and hydrology at Masaryk University, Brno. Senior scientist at CHMI since 2003. Special skill in databases and software development. Research experience in climate modeling validation, land-surface data assimilation, statistical processing of climatological time series, homogenization.

Mgr Ales Farda, Degree in Environmental sciences and meteorology, PhD student at CUNI. Position junior climatologist at Czech Hydrometeorological Institute since 2003, specialist in climate of the Central Europe, experience with regional climate modelling. Mgr. Stanislav Lejska, experience in hydrological modeling, water balance, climate change impacts on hydrological cycle, results analysis. RNDr. Mojmír Kohut, agrometeorological modeling, moisture balance, evaporation and evapotranspiration analysis. Mgr. Jan Macoun, Ph.D., air pollution modeling, air quality data analysis

Selected recent relevant publications:

Huth, R. Mládek, R., Metelka, L., Sedlák, P., Huthová, Z., Kliegrová, S., Kyselý, J., Pokorná, L., Halenka, T., Janoušek, M. (2003): On the integrability of limited-area numerical weather prediction model ALADIN over extended time periods. Studia geophysica et geodaetica, 47, 863-873, 0039-3169.

Hladný, J. et al. (1997): Impacts of a potential climate change on hydrology and water resources in the Czech Republic. Czech Hydrometeorological Institute, Prague, 135 pages.

Rožnovský, J., Kohut, M. (2001): The Course of Potencial Evapotranspiration in the Vegetation Season of the Years 2000, 2001. Contributions to Geophysics and Geodesy, 31, č. 2, s. 483-493.

A.1.7. Institute of Atmospheric Physics, Academy od Science of Czech Republic (IAP)

Institute of Atmospheric Physics deals with research on the atmosphere in its whole depth, ranging from the boundary layer up to interplanetary space. Climatological research is conducted within its Dept. of Climatology and Aeronomy. The climatological team is experienced in climate change research as well as in statistical climatology. Their expertise includes statistical downscaling, stochastic weather generators, analyses of climate variability and change with emphasis on extreme events, construction of climate change scenarios, and their use in climate change impact studies on agriculture, hydrology, and water quality. The members of the team participate in many national research projects, as well as in international projects of the 5th and 6th Framework Programme of the EU, NATO collaborative research grants, and COST projects. IAP is a member of the consortium of the ENSEMBLES project.

IAP will co-coordinate WP3 of the present project; its staff will contribute to WP3 mainly by provision of statistical downscaling methods, validation of climate models, and construction of climate change scenarios. IAP will also contribute to WP4 by analysis of extreme temperature events, and to WP5 and WP6 in assessments of climate change impacts on agriculture and hydrology, respectively, by making use of the appropriate crop growth and rainfal-runoff models.

Key persons:

Dr. Radan Huth, graduated in meteorology and climatology from the Charles University, Prague, in 1987; post-graduate studies 1988-1992, thesis defended in 1993. Professional experience: Institute of Atmospheric Physics since 1987, now senior research scientist. Head of Dept. of Climatology and Aeronomy; chair of the Sceintific Council of IAP. Vice-chair of the National Climate Programme of the Czech Republic. Principal investigator of many research projects funded by national grant agencies. Participant in several international projects (U.S. Country Studies Programme, EU ENRICH programme, 5th and 6th FP EU, COST). Published over 25 papers in international refereed journals. Member of editorial/advisory boards of international journals: Int. Journal of Climatology, Studia Geophysica et Geodaetica, Meteorologische Zeitschrift. Winner of the Int. Journal of Climatology Prize awarded by the Royal Meteorological Society, UK. Professional interests: statistical climatology, synoptic climatology, general atmospheric circulation, climatic change.

Dr. Martin Dubrovský, graduated in meteorology and climatology from the Charles University, Prague, in 1986; doctoral studies at the Charles University, 1991-1996; Professional interests: climate change and its impacts, stochastic models, application of statistical methods in meteorology.

Dr. Jan Kyselý, graduated in meteorology and climatology from the Charles University, Prague, in 1997; doctoral studies at the Charles University, 1997-2001; Professional interests: extreme value analysis, climate variability and change, biometeorology, statistical modelling.

Selected recent relevant publications:

Huth, R., Kyselý, J., Dubrovský, M., 2001: Time structure of observed, GCM-simulated, downscaled, and stochastically generated daily temperature series. J. Climate, 14, 4047-4061.

Hejzlar, J., Dubrovský, M., Buchtele, J., Růžička, M., 2003: The apparent and potential effects of climate change on the inferred concentration of dissolved organic matter in a temperate stream (the Malše river, South Bohemia). Sci. Tot. Environ., 310, 143-152.

Trnka M., Dubrovský M., Žalud Z., 2004: Climate change impacts and adaptation strategies in spring barley production in the Czech Republic. Clim. Change, 64, 227-255.

Huth, R., 2004: Sensitivity of local daily temperature change estimates to the selection of downscaling models and predictors. J. Climate, 17, 640-652.

Kyselý, J., Dubrovský, M., 2005: Simulation of extreme temperature events by a stochastic weather generator: Effects of interdiurnal and interannual variability reproduction. Int. J. Climatol., 25, 251-269.

A.1.8. Swiss Federal Institute of Technology, Zurich (ETH)

The Institute of Atmospheric and Climate Science at ETH Zürich has long and wide-ranging expertise in atmospheric physics and chemistry, weather prediction, climate research, hydrology, and glaciology. The Swiss Federal Institute of Technology (ETH) is the leading Swiss university in the areas of natural sciences and engineering, with about 13,000 students and 6000 staff. The institute has a staff of about 100 researchers, technicians and Ph.D. students.

Key persons:

Dr. S.I. Seneviratne. Degree in Environmental Sciences and PhD (2002) in atmospheric and climate science from ETH. Post-doctoral position at NASA/GSFC (Greenbelt, Maryland) on land-surface atmosphere interactions (2003-04). Senior scientist at ETH since January 2005, since 2007 Associate Professor. Research experience in regional climate modeling, land-surface data assimilation, land hydrology (soil moisture memory, land-atmosphere feedback processes), and basin-scale hydrology (GRACE, water-balance diagnostics). Dr Seneviratne is presently Co-PI in the ETH contributions to the EU-project ENSEMBLES as well as to the Swiss National Center for Competence in Research NCCR-Climate.

Prof. Ch. Schär Physics degree and Ph.D. (1989) in atmospheric dynamics from ETH. Post-doctoral positions at the Yale University (New Haven, CT) and the University of Washington (Seattle, WA). Assistant professor at ETH (1992), associate professor (1998), full professor since 2001. Member (1997-2004) and chairman (2002-2004) of the Scientific Advisory Committee of the ECMWF (Reading, UK). Associate Editor of the Journal of the Atmospheric Sciences (1993-1998) and the Quarterly Journal of the Royal Meteorological Society (2000-). Prof. Schär's group has been involved in several national and international projects on regional climate modelling and/or extreme events analysis, in particular the EU-projects MERCURE, PRUDENCE, STARDEX and ENSEMBLES, as well as in the Swiss National Center for Competence in Research NCCR-Climate.

Selected recent relevant publications:

Hirschi, M., S.I. Seneviratne and C. Schär, 2005: Seasonal variations in terrestrial water storage for major mid-latitude river basins. J. Hydrometeorol., in press

Schär, C., P.L. Vidale, D. Lüthi, C. Frei, C. Häberli, M.A. Liniger and C. Appenzeller, 2004: The role of increasing temperature variability for European summer heat waves. Nature, 427, 332-336

Seneviratne, S.I., J.S. Pal, E.A.B. Eltahir, and C. Schär, 2002: Summer dryness in a warmer climate: A process study with a regional climate model. Climate Dynamics, 20, 69-85

Seneviratne, S. I., P. Viterbo, D. Lüthi and C. Schär, 2004: Inferring changes in terrestrial water storage using ERA-40 reanalysis data: The Mississippi River basin. J. Climate, 17, 2039-2057

Vidale, P.L., D. Lüthi, C. Frei, S.I. Seneviratne, and C. Schär, 2003: Predictability and uncertainty in a regional climate model. J. Geophys. Res. Atmos., 108 (D18), 4586, doi: 10.1029/2002JD002810

A.1.9. Inst. of Meteorology, Univ. of Natural Resources and Applied Life Sciences (BOKU), Austria

The Institute of Meteorology (BOKU-Met, http://www.boku.ac.at/imp/met/indexe.html) at BOKU (Universitaet fuer Bodenkultur, University of Natural Resources and Applied Life Sciences) is part of the Department of Water, Atmosphere and Environment. It has a permanent scientific and technical staff consisting of one full professor, 3 associate professors, 2 technicians and a project-funded staff of presently 6 (senior and junior) postdocs, 4 postgraduates and 1 technician.

BOKU-Met is active in the fields of environmental meteorology and climate change research, agricultural meteorology, atmospheric radiation, and small-scale boundary-layer climatology. Activities include numerical modelling as well as field measurements.

Key persons

Prof. Dr.Helga Kromp-Kolb: Head of the Institute of Meteorology (BOKU-Met) since 1995. Research interests: Climate change and environmental meteorology. Relevant research projects: Coordinator of the interdisciplinary StartClim programme "First analyses of extreme weather events and their impacts on Austria" (2003, 2004); ACCENT EU NoE (Member of Steering Committee on Public Information and Policy Support) ; STACCATO: Vertical Exchange in Troposphere and Stratosphere (EU-funded project, IP); VOTALPI and II - Vertical Ozone Transport in the Alps (EU-funded projects; Coordinator).

Awards: Konrad Lorenz Environmental Award 1991; Austrian Scientist of the year 2005.

Ao. Prof. Dr. Dipl. Ing. Josef Eitzinger: Head of the Working Group of Agrometeorology at BOKU-Met. Member of the WMO RA VI Commission for Agrometeorology (CAgM) Expert Team on "Impact of Climate Change Variability on Medium- to Long-Range Predictions for Agriculture".

Dr. Herbert Formayer: Since 1998 researcher at BOKU-Met with the main research activities in regional climate analyses, downscaling of climate change scenarios for the alpine region and climate change impact studies.

Dr. Bernd C. Krüger: PhD in chemistry (University of Göttingen, 1983). Main field of research is modelling of atmospheric chemistry. Experience in regional modelling of the atmospheric boundary layer as well as in global modelling of the stratosphere.

Selected recent relevant publications

Wotawa, G., Stohl, A., Kromp-Kolb, H. (1997): Estimating the uncertainty of a Lagrangian photochemical air quality simulation model caused by inexact meteorological input data. Reliability Engineering & System Safety, 57, 31-40.

Alexandrov, V., Eitzinger, J., 2005. The Potential Effect of Climate Change and Elevated Air Carbon Dioxide on Agricultural Crop Production in Central and Southeastern Europe. Journal of Crop Improvement 13(1-2): 291-331.

Matulla, Ch., Penlap, E.K., Haas, P. and H. Formayer (2003): Comparative Analysis of Spatial and Seasonal Variability: Austrian Precipitation during the 20th Century. International Journal of Climatology, 23, 13, 1577--1588.

Krüger, B.C., Schmittner, W., Kromp-Kolb, H., 2002, Air Quality Model System for the Vienna/Bratislava Region. In: Midgley, P., Reuther, M. (Eds.), Transport and Chemical Transformation in the Troposphere, Proceedings of EUROTRAC Symposium 2002, Margraf Verlag.

A.1.10. National Meteorological Administration (NMA)

National Meteorological Administration – NMA (http://www.inmh.ro) represents the national authority in the field of meteorology in Romania acting within the Ministry of Environment and Water Management. The department responsible for conducting the major research activities is the Dynamic Meteorology, Climatology and Agrometeorology. Here, the research activity is carried out within specialised research groups: Numerical modelling group, Climate Research group and, Agrometeorological group.
The numerical modeling group is in charge with maintaining and developing the Aladin limited area model and producing user-oriented interfaces and applications. The regional climate models and global models outputs are used in research studies on physical mechanisms responsible for local and regional climate.
The research activity within Climate Research Group encompasses climate variability and change at regional scale and climate predictability. The main topics are: characteristics of climate variability over Romania based on long term observations, connection between Romanian climate and large-scale mechanisms, projection of global climate change on local scale using statistical downscaling models, validation of global/regional climate models on large and regional scales.
The Agrometeorology group is oriented towards impact studies on climate changes on agricultural crops and on main components of soil water balance.
NMA has been involved in international research collaborations such as ALADIN and LIFE ASSURE - an international partnership with Meteo-France. Among the ongoing FP6 and other international projects are: ENSEMBLES, DYNAMITE, IPY-CARE, ALATNET, LIFE AIRFORALL and AIRAWARE and two COST Actions relevant to the present proposal: COST Action 733- Harmonization and Applications of Weather Types Classifications for European Regions and COST Action 718 – Meteorological Applications for Agriculture.

Key persons:
Dr. Constanta Boroneant, is senior researcher in the Climate Research Group. Her research interests and expertise is on regional aspects of natural climate variability, extreme events, anthropogenic influence on climate, GCM and RegCM validation.
Dr. Aristita Busuioc, senior scientist, is leading the Climate Research Group. She has a long experience in statistical downscaling models and validation of the global (regional) climate models.
Dr. Mihaela Caian, senior scientist, is leading the Numerical-modeling group. She has more than 15-year experience in numerical modeling for meteorology. She has been participated in the construction and development of ALADIN and RegCM model for Romania.
Dr. Elena Mateescu, senior scientist is leading the Agro meteorology Group. She is specialised in impact studies on climate change on agriculture, crop vulnerabilty to the extreme climatic events.

The NMA will contribute with producing the high-resolution (10 km) simulations over Romania (WP2), statistical downscaling model, comparison with high-resolution simulations (WP3), changes in extremes and circulation patterns (WP4), climate change impact on Black Sea coast (WP5) and on crop yield and C-cycle in agriculture (WP6).

Selected recent relevant publications:

Caian M. and J.D.Haigh, 2002 : "Eddy-mean flow interaction in the presence of diabatic perturbed tropopause". UGAMP Letters

Boroneant C, G.Plaut, F. Giorgi, X.Bi, (2005): Extreme precipitation over the Maritime Alps and associated weather regimes simulated by a regional climate model: Present-day and future climate scenarios, Theoretical and Applied Climatology, (accepted)

Busuioc A, von Storch H, 2003: Conditional stochastic model for generating daily precipitation time series, Climate Research 24, 181-195.

A.1.11. National Institute of Meteorology and Hydrology, Bulgaria (NIMH)

The National Institute of Meteorology and Hydrology (NIMH) (www.meteo.bg) at the Bulgarian Academy of Sciences is the official hydrometeorological service in Bulgaria. NIMH was established in February 1890. Its primary mission is to provide meteorological and hydrological information and products to different organizations and users in Bulgaria. Its duties comprise both operational and applied research activities. Hydrological and meteorological observations, data acquisition and telecommunication, monitoring the air and surface and ground water, meteorological (www.weather.bg) and hydrological forecasts (http://mesta.meteo.bas.bg), assistance to special sectors through applied maritime meteorology and agrometeorology, maintenance of data base, scientific researches, numerical and statistical modeling are the general duties of NIMH.

The research activities are concentrated mainly in the Central Office in Sofia. Its permanent staff consists of 68 highly qualified researchers (38 Ph.D., 5 D.Sc.). NIMH has been and actually is partner in many international research projects and programmes.

In this project NIMH will participate in WP2, WP3, WP4,WP6 and WP7. In WP2 the ALADIN-CLIMATE model will be used for the scenarios over the region of Balkan Peninsula. The same region will be used for statistical downscaling in WP3 and impact on the air pollution in WP7.

Key persons:

Dr. Valery Spiridonov, senior scientist, member of the Scientific Council on Geophysics, Deputy Director. Experience in numerical modelling and forecast, objective analysis, climate modelling, head of Bulgarian group of the international project ALADIN.

Dr. Vesselin Alexandrov, senior scientist, head of the Department of Meteorology, member of the WMO RA VI Commission for Agro meteorology. Experience and research in climate variability and change and their impacts on various sectors; crop-weather model applications; agro-climatology; weather-generators. Miloshev Nikolai Georgiev, Institute of Geophysics, Bulgarian Academy of Sciences, Director of Geophysical Institute. Experience and research in air emission inventories, air pollution model studies, air quality, phase transitions, microphysics and chemistry. Dr. Andrey Bogatchev, climate change impacts, statistical evaluation of model results, Maria Prodaniva, atmospheric chemistry, air pollution numerical modelling. Dr. Ekaterina Koleva, climate variability and change, weather extremes, Liliana Iordanova, atmospheric chemistry, air pollution, Dr. Konstantin Ganev, (contract), atmospheric chemistry, air pollution.

Selected recent relevant publications:

Spiridonov, V., Gospodinov, I., and Geleyn, J.-F., 2001: Second order accuracy of two-time-level semi-Lagrangian schemes. Q. J. R. Meteorol. Soc., 127, 1017-1033.

Alexandrov, V. and J. Eitzinger, 2005. The Potential Effect of Climate Change and Elevated Air Carbon Dioxide on Agricultural Crop Production in Central and Southeastern Europe. Journal of Crop Improvement 13(1-2): 291-331.

Alexandrov, V., M. Schneider, E. Koleva and J-M. Moisselin, 2004. Climate Variability and Change in Bulgaria during the 20th Century. Theoretical and Applied Climatology 79(3-4): 133-149.

Zerefos Ch., D. Syrakov, K. Ganev, A. Vasaras, K. Kourtidis, M. Tzortziou, M. Prodanova,R. Dimitrova, E. Georgieva, D. Yordanov, N. Miloshev, (2004), Study of the pollution exchange between Bulgaria and Northern Greece. Int. J. Environment & Pollution, vol. 22, No.1/2, 163-185.

A.1.12. National Institute of Hydrology and Water Management (NIHWM)

The National Institute of Hydrology and Water Management (NIHWM) develops research activities and provides operational services of national and international public interest for the protection and socio-economic well-being of people. NIHWM was established under its current name in December 2002, but, as different organizations, its activities are over 50 years old. NIHWM performs research, conducts studies, and provides technical assistance in the areas of short, medium, and long-range hydrologic forecasts, warnings of dangerous hydrologic events for prevention and management of crisis situations (floods, droughts) and mathematical modelling of surface and groundwater resources, hydrological and hydrogeological synthetic parameters. The institute is active as well in water management, ecohydrology, impact of human activity and of the climate changes on the hydrological regime, hydrological and hydrogeological data base development with GIS hydrological applications.

Key persons:

Rodica MIC (18 years experience), permanent, Doctor in hydrology, senior researcher, activity in the research studies concerning the models for hydrological forecast, critical thresholds of precipitation for the hydrological warning, flood regional modelling by flow-duration-frequency approach. Participation to the international projects and co–director to the NATO SfP 978016, expertise in statistical evaluation of model results, coordination of WP5.

Ciprian CORBUS (22 years experience), permanent, Doctor in hydrology. Head of Dynamic and Experimental Hydrology Department, participation or coordination to the research studies, concerning: the rainfall - runoff modelling, Research of the natural and anthropic impact of the climatic changes upon the water balance on a hydrographical basin. Participation to the international projects, experience in the assessment of climate change impacts on the hydrological resources.

Ion TECUCI, Doctor, Senior researcher, permanent, 40 years of professional activity in the field of water resources management, dam, reservoir and bypass channel design, climatic changes influence on water resources, analysis of vulnerability of the water resources, modifications and adaptation measures.

Elisabeta OPRISAN, (24 years experience) PhD Candidate, activity in the field of water resources management, engineering hydrotechnical structures design.

Selected recent relevant bibliography:

Mic R., Galéa G., Javelle P., (2002) Modélisation régionale des débits de crue du bassin hydrographique du Cris (Roumanie) : approche régionale classique et par modèles de référence. - Revue des Sciences de l'Eau, - 15(3)/(2002), p.677-700.

Mic R., Galéa G., Javelle P., (2002) Floods regionalization of the Cris catchments: application of the converging QdF modelling concept to the Pearson III law. - XXI th Conference of the Danube Countries - Bucharest 2 - 6 sept. 2002.

Stănescu V. Al., Corbuş C., Ungureanu V., Simota M. (1998) Quantification of the hydrological regime modification in the case of climatic changes. Conference on Climate and Water, 17-20 August, Espoo, Finland, p. 198-207

Simota C., Corbuş C., Simota M. (2000) Using Weather Data Generators for an Evaluation of the Effect of Climate Changes upon the Hydrological Regime at a Catchment Scale. XXth Conference of the Danube Countries on Hydrological Forecasting and Hydrological Bases of Water Management, 4-8 September, Bratislava, Slovakia, p. 148

Corbuş C., Stănescu V. Al. (2004) The Stability Of The Hydrological Regimes: A Hydroecological Descriptor Of River Life. Conference on Water Observation and Information System for Decision Support, 25-29 May, Ohrid, Republic of Macedonia.

A.1.13. Hungarian Meteorological Service (OMSZ)

The Hungarian Meteorological Service (OMSZ) is the main meteorological and climate information provider organisation in Hungary. The most relevant organization unit of OMSZ related to the recent project is the Division for Numerical Modelling and Climate Dynamics, which is responsible for the numerical prediction activity including the adaptation, development and operational application of numerical models. This Division has a special expertise in the use and development of the ALADIN meso-scale limited area model that has been run operationally at OMSZ since 1997. The other important participating unit of OMSZ is the Division for Evaluation and Methodology with the expertise of statistical analysis of meteorological events, methodological developments in the field of statistical climatology and the analysis of extremes.

In this project, OMSZ will participate in WP2, WP3 and WP4. In WP2 OMSZ will apply its numerical modelling expertise and computational resources to perform the desired RCM simulations using the climate version of the ALADIN model. In WP3 OMSZ will work on the validation of the RCM runs and in WP4 on the analysis of extremes in the climate simulations.

Key persons:

Dr. Mónika Lakatos, researcher in the Division for Evaluation and Methodology. She has been working at OMSZ since 1988. Her scientific interest is related to statistical climatology, statistical modelling of extreme meteorological events and time series analysis. She has recently got a PhD degree with the thesis "Mathematical Modelling of Extreme Meteorological Events". In this project her task is the statistical investigation of the extremes in the RMC runs performed at OMSZ. As a local-coordinator at OMSZ she will synchronize the execution of the different tasks.

Sándor Kertész, researcher in the Division for Numerical Modelling and Climate Dynamics. His main interest is numerical weather prediction especially data assimilation with the ALADIN model and he also has a great experience in verification. He will take part in the evaluation of the ALADIN based RCM runs.

Dr. László Kullmann, PhD in statistical physics, researcher in Division for Numerical Modelling and Climate Dynamics. His main scientific interest is numerical weather prediction with a great emphasis on the physical parameterization schemes. Additionally he manages most of the technical tasks related to the installation and operational usage of the ALADIN model at OMSZ. In this project he will maintain and manage the ALADIN model used for the high resolution RCM runs at OMSZ.

Helga Tóth, researcher in the in Division for Numerical Modelling and Climate Dynamics. Her work has been related to verification and numerical weather prediction with the ALADIN model. Recently she has been working on regional climate modelling with the climate version of the ALADIN model. In this project she will be responsible for the adaptation, running and evaluation of the high resolution climate version of ALADIN.

Selected recent relevant publications:

Kertész S., Szépszó G., Lábó E., and Randóti G., 2005: Dynamical downscaling of the ECMWF ERA-40 re-analyses with the ALADIN model. ALADIN Newsletter 28., 78-83.

Lakatos, M., Matyasovszky, I., 2004: Analysis of the extremity of precipitation intensity using the POT method. Időjárás, 108., 3., 163-171.

A.1.14. Forest Research Institute Zvolen (FRI)

The Forest Research Institute Zvolen (1898-2005) is the national centre for the forestry oriented research in Slovakia with research interests in forest ecology, biodiversity, silviculture, forest protection and forest management. The team from Forest Research Institute has experience in a range of climate change impacts on land management (forestry, agriculture), forest ecosystem modelling (forest gap models, growth models, bioclimatological models), natural hazards and carbon cycle. It has been involved in several several international and national projects related to climate change issues (U.S. Country Study, CARBOMONT, WARM).

Key persons:

Dr. Tomas Hlásny has been working at Forest Research Institute Zvolen since 2004. Before, he had been working for six years at Matej Bel University as GIS lecturer. He obtained his PhD. in 2004 in Landscape Ecology, as well. In the past, he participated in the Tempus - Phare AC_JEP-13-13411-98 METEA (1998-2001). At present, Dr. Tomáš Hlásny works as junior scientist engaged mainly in GIS, Remote Sensing, geostatistics and spatial modelling.

Dr.Ing.Jozef MINDAS, PhD. – senior scientist, has been working at the Department of Ecology and Biodiversity of Forest Ecosystems (Forest Research Institute Zvolen) since 1990. He is oriented on the research activities focused on the climate change and air pollution impacts on forest ecosystems. He has been involved in several international and national projects related to climate change issues (U.S. Country Study, CARBOMONT, WARM).

Dr.Ing.Bernard SISKA, PhD. – senior scientist, has been working at Slovak Agriculture University Nitra since 1986. He is oriented on the research activities focused on the climate change impacts and crop yield modelling. He has been involved in several international and national projects related to climate change issues (U.S. Country Study, MARS-JRC).

The role of the FRI in the project will be to coordinate the activities and take the lead in workpackage WP6 (forestry and agriculture). Main task is the modelling of the climate change and air pollution impacts on forest ecosystems at the regional scale. Moreover, FRI will actively participate in WP5 where will contribute by the linkages between land management (forestry, agriculture) and hydrology.

Selected recent relevant publications

Lapin,M.- Mindas,J.-Zavodsky,D.-Majercakova,O.-Spanik,F.: Preliminary Results of Vulnerability and Adaptation Assessment for Slovakia. In: Vulnerability and Adaptation to Climate Change. U.S.Country Studies Program, Kluwer Academic Publishers, Dordrecht, Boston, London 1996: 295-312.

Mindas, J., 2000: Expert Assessments on the Likely Impacts of Climate Change on Forests and Forestry in Europe – Slovakia. In: Kellomäki,S.-Karjalainen,T.-Mohren,F.-Lapveteläinen,T. (Eds.): Expert Assessments on the Likely Impacts of Climate Change on Forests and Forestry in Europe. EFI Proceedings No.34, 2000: 95-100.

Mindas, J.-Skvarenina, J.-Strelcova, K.-Priwitzer, T., 2000: Influence of climatic changes on Norway spruce occurrence in the West Carpathians. Journal of For. Sci.46, 2000 (6): 249-259.

Kucera, L.– Trnka, M.– Siska, B.-Genovese, G.–Laszlo, I.–Knapic, M.: Crop monographies on central European countries: The MARS Crop Yield Forecasting System, vol. 3: Czech republic, Slovakia, Hungary, Slovenia, Luxembourg Office for Official Publication of the EC, 2004, 1-45, ISBN 92-894-8175-5 (EUR 21290 EN/1).

Hlasny T., 2003: Landscape heterogeneity as a measure of landscape system entropy, In: Ekológia (Bratislava), Vol.22, Suppl. 2 / 2003, p. 130-140.

A.1.15. Warsaw University of Technology, Poland (WUT)

The team from Warsaw University of Technology in Warsaw has expertise in the field of Boundary Layer Meteorology, Air Quality Modelling for regional and local scale, Integrated Assessment Modelling (IAM) for Air Pollution and the impact analysis. The regional AQM's for Poland were developed to calculate sulphur and nitrogen species concentration/deposition. The ROSE modeling system, developed and implemented specifically for Poland, deals with the impact of airborne sulphur species on the environment and belongs to the family of an effect-based IAM's. Open source CALMET/CALPUFF model were implemented and used for many local scale applications in Poland, with the chemical scheme MESOPUFF (SO2, NOx, PM10, PM2.5, secondary aerosols). The research on statistical evaluation of model results comparing with station data have been performed as well. WUT has participated and coordinated in several EU (Copernicus, Esprit), other international and national projects. In addition, it has provided numerous consultations to local and national governmental authorities and organizations in its field of expertise.

In the project, WUT will take the lead in WP7 and will participate in WP2 and WP6. The main emphasis in WP7 will be put to drive AQMs with meteorological fields from RCM, to analyze and evaluate modeling results and to estimate key species exceedances of the EU limits. In WP2 WUT will contribute by the studies of the sensitivity of RCM with respect to the convective scheme in use within the framework of WP2, as well as in the development of improved parameterization schemes for RCM. In WP6 WUT will contribute to integrated assessment of climate change and air pollution impacts on forest ecosystems in selected region, with emphasis to impacts from sulphur species.

Key persons:

Associate Professor, D.Sc. Katarzyna Juda-Rezler - Researcher and teacher at the Institute of Environmental Engineering Systems, Warsaw University of Technology (WUT). Head of the Meteorology and Air Pollution Control Department. Beside others, she is a member of the EURASAP - European Association for the Science of Air Pollution (since 1985) and of the „Man and Environment" Scientific Committee of Polish Academy of Sciences (since 1999). She has a more than 20 year experience in Air Quality Modelling as well as air pollutants impact on the environment. She has published more than 20 papers in international journals and books with peer review. She will lead WP7.

Professor, D.Sc. Zbigniew Sorbjan – Research Associate Professor at Marquettte University, Milwaukee, USA. His research areas are in The Boundary-Layer Meteorology, Large-Eddy Simulations, Similarity Theories. He authored several scientific and popular books on meteorology and over 50 papers in peer-reviewed journals and conference proceedings.

They will be assisted by three research workers and two post-graduate research assistants.

Selected recent relevant publications:

Juda-Rezler K., 2004. Risk Assessment of Airborne Sulphur Species in Poland. In: Air Pollution Modelling and its Application XVI, eds.: C. Borrego and S. Incecik, Kluwer Academic/Plenum Publishers, New York 2004, pp. 19-27.

Juda-Rezler K., 2004. Modelling of the air pollution by sulphur species in Poland. Environmental Protection Engineering, Vol. 30, No. 3, 53 70.

Sorbjan Z., 2004: Large-eddy simulations of the baroclinic boundary layer. Boundary-Layer Meteorology, 112, 57-80.

Sorbjan Z., 2004: Air-pollution Meteorology. Chapter 4 in: Air Quality Modelling, Ed. P. Zannetti.

A.1.16. Eötvös Loránd University, Budapest, Hungary (ELU)

The Eötvös Loránd University, established in 1635, is one of the best universities of Hungary, located in Budapest. The Dept. of Meteorology was established in 1945. The present main research activity of the department includes dynamical modelling of atmospheric processes, statistical downscaling of global climate change, analysis of climatological extremes, estimation of regional climate change, monitoring and modelling of the regional carbon balance, soil-vegetation-atmosphere transfer modelling. In relation to this proposal mainly participation in EU FP4 Project GRAMINAE, FP5 Projects AEROCARB, CHIOTTO, and GREENGRASS, and FP6 Project CARBO-EUROPE will provide benefits for the progress of this study.

In this project, ELU will contribute by the experiments with the regional climate model RegCM3 for the Carpathian Basin in WP2. In WP3, ELU will co-operate in downscaling GCM outputs for the Carpathian Basin using stochastic-dynamic technique. In WP4, ELU will collaborate in analysis of extreme climate indices for the Carpathian Basin using the WMO-CCl/CLIVAR Working Group's suggestions. Finally, in WP6, ELU will participate in studies of the climate change impacts on agriculture using the BIOME-BGC Model (Max Planck Institute).

Key persons:

Prof. Judit Bartholy, head, and professor of climatology since 1991, CSc since 1986. Previously, 16 year experience in climate forecast at the OMSZ. Co-ordinator of national research projects on regional climate change based on dynamical down-scaling, climate change impacts on regional air quality, satellite application to urban climatology. Participated in EU5 projects AEROCARB and CHIOTTO with regional carbon balance monitoring and modelling. Secretary of the Scientific Commission on Climatology of the Hungarian Academy of Sciences (HAS). She published 31 refereed journal papers and 65 extended abstracts in conference proceedings.

Dr. Rita Pongrácz, assistant professor since 2004, PhD since 2003. Research participant of several national and international projects. She received the Bolyai Janos Research Fellowship of HAS between 2001 and 2003. She published 17 refereed journal papers and 42 extended abstracts in conference proceedings.

Dr. Zoltán Barcza, assistant professor since 2002, PhD since 2001. Hungarian co-ordinator of the CARBOEUROPE-IP in the frame of the EU6 program from 2004. He received the Bolyai Janos Research Fellowship of HAS in 2003-2005. He published 8 refereed journal papers and 10 extended abstracts in conference proceedings.

Selected recent relevant publications:

Bartholy J., Pongrácz R., 2005: Tendencies of extreme climate indices based on daily precipitation in the Carpathian Basin for the 20th century. Időjárás 109: 1-20.

Barcza, Z., Haszpra, L., Kondo, H., Saigusa, N., Yamamoto, S., Bartholy, J., 2003: Carbon exchange of grass in Hungary. Tellus 55: 187-196.

Bartholy J., Matyasovszky I., Weidinger T., 2001: Regional climate change results in Hungary: a stochastic downscaling method. Időjárás 105: 1-17.

Matyasovszky I., Weidinger T., Bartholy J., Barcza Z., 1999: A review of the present state of regional climate change studies in Hungary. Geogr. Helvetica 54: 145-153.

A.2. Sub-contracting

No subcontracting supposed, all the work on the project can be provided by the partners.

A.3. Third parties

No third parties supposed.

A.4. Funding of Third country participants:

No partners out of EU Members or Associated States, with regard to the targeted area there is no need for that.

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