ENSEMBLES
Newsletter

Issue 1 January 2005

The ENSEMBLE-based Predictions of Climate Changes and their impacts (ENSEMBLES) project (contract number GOCE-CT-2003-505539) is supported by the European Commission's 6th Framework Programme as a 5 year Integrated Project from 2004-2009 under the Thematic Sub-Priority "Global Change and Ecosystems".

The ENSEMBLES RT8 group is pleased to present the first issue of the project newsletter. A general description of the project is provided along with a brief description of the partial research themes. The current work activities for each research theme are presented and planned future work and objectives are discussed.

Edited by E. Kostopoulou and C. Giannakopoulos
National Observatory of Athens, Greece
M. Beniston
University of Fribourg, Switzerland

Project summary

ENSEMBLES aims to maintain and extend European pre-eminence in the provision of policy relevant information on climate and climate change and its interactions with society. State-of-the-art, high resolution, global and regional Earth System models developed for Europe will be utilised to produce an objective probabilistic estimate of uncertainty in future climate. The models will be validated against quality controlled, high resolution gridded datasets for Europe and applied at seasonal to decadal and longer timescales. A major aspect of the project is to quantify and reduce the uncertainty included in the representation of physical, chemical, biological and anthropogenic - related feedbacks in the Earth System. An overall of 72 institutions comprise the consortium of the project, covering a wide range of research topics. In order to maximise the utility of the project outputs, the results of the ensemble prediction system will be related to various socio-economic sectors including health, food security, insurance, agriculture, energy, water resources and weather risk management.

The project consists of 10 interrelated Research Themes (RT), while each RT is divided into several Work Packages (WP). The overall coordination and management of the project is provided by RT0. RT1 deals with the development of a global, high-resolution modelling system for the prediction of climate change and its impacts. RT2 is divided in RT2A and RT2B. The former is occupied with the construction of hindcasts and climate change scenarios ranging from seasons to decades and centuries, while the latter will produce probabilistic high resolution regional climate scenarios for impact assessments. Formulation of a high resolution multi-model ensemble for Europe, from decadal to longer timescales, is undertaken in RT3. The purpose of RT4 is to advance the understanding of the key processes and factors governing the climate variability, change and predictability as well as the probability of extreme events. The evaluation of the ENSEMBLES simulation -prediction system against observations/analyses is the main task within the responsibilities of RT5. Assessments and impacts of climate change are studied in RT6, whereas scenarios and policy implications are analysed by RT7. Finally, the aim of RT8 is to disseminate results of the ENSEMBLES project emerging from all RTs and particularly to project the main outputs from RT6 and RT7 to the wider public and the stakeholder community. Furthermore, new areas of education and training will open up for researchers, who are interested to the novel concepts developed within the ENSEMBLES framework, through training courses and workshops organised by RT8.

RT0: Project integration, management and promotion.

The ENSEMBLES project started officially on the 1st of September 2004 with the Kick-off meeting being held on 15-16 September in Hamburg. The meeting was organised by Chris Hewitt (ENSEMBLES Director), Daniela Jacob and others of the Max Planck Institute. Dave Griggs (ENSEMBLES Coordinator) chaired the first ENSEMBLES Management Board (EMB) meeting on the 17th of September. Among others, the meeting allowed discussions on the way the plenary had gone and participants had the opportunity to share thoughts and views regarding the improvement of work practices between related RTs, the contents of the project website, the establishment of timetables for project reporting and any further issues anyone wished to raise.

The Project Office now has a full complement of staff with the official appointment of Pip Gilbert as ENSEMBLES secretary in October. Since the Kick-off and EMB meetings, RT0 have been occupied with setting up the Project Office, building up the project website, designing an ENSEMBLES logo, submitting a meeting report to Eos (the weekly newspaper of the geophysical sciences, published by the AGU), working through the various actions that arose from the EMB, monitoring milestones and deliverables, and working towards a signed contract with the European Commission so that the pre-financing can be released and distributed to the consortium as soon as possible.

Work is now underway to organise the second EMB and the second plenary meeting, and RT0 is looking forward to following developments in, and working with, all the other RTs.

RT1: Development of the Ensemble Prediction System

The development of a global, high resolution, fully comprehensive, ensemble based, modelling system, for the prediction of climate change and its impacts, is a major target of ENSEMBLES. In order to achieve the objectives of RT1, the first step will be to assemble currently available Earth System model component modules, to provide models for use in the ensemble prediction system. The resulting Earth System models will then be used to develop and test different schemes to represent model uncertainty in seasonal to centennial prediction.

Three approaches will be considered, consisting of a multi-model ensemble, an ensemble generated by perturbing uncertain parameters in a single model an ensemble sampling stochastic parameterisation uncertainties in a single model. Figures 1 and 2 illustrate the importance of developing ensemble-based approaches, using results from the first two methods. Figure 1 depicts the ranked probability skill score (RPSS) of 1-month lead seasonal tropical precipitation hindcasts (initialised on the 1st of November during the period 1987-1999) as a function of the ensemble size. The blue RPSS bars have been obtained from a single model, while the red bars correspond to the DEMETER multi-model (seven 9-member ensemble single models). The skill of the probabilistic multi-model hindcasts is superior to that of the single model of the same ensemble size. This result is representative of other regions and variables. Figure 2 shows a histogram of possible winter (December to February) warming over Northern Europe for a doubling of atmospheric carbon dioxide, illustrating the importance of sampling modelling uncertainties in a large ensemble to quantify the range of possible outcomes.

To estimate forecast uncertainty, 200 different versions (introducing perturbations in the physical parameterisations) of the Hadley Centre model were used. The height of each bar shows the number of simulations, which fall within the range indicated on the abscissa. To formulate recommendations for the generation of reliable ensemble predictions, a set of pre-production experiments at seasonal to decadal and longer timescales will be performed, including a common archive of the output, and the results evaluated. The seasonal to decadal experiments will be initialised using the last generation of ocean analyses, also developed within RT1. The results of these pre-production experiments will be relevant for the design of the RT2A production system.

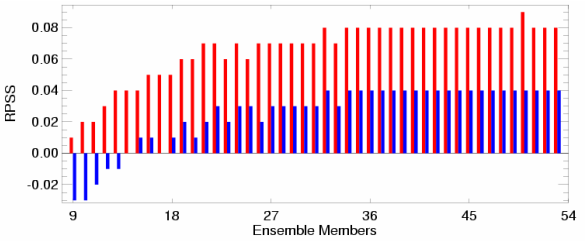

Figure 1: *Precipitation ranked probability skill score (RPSS) over the tropics. Forecast start month and years: November 1987-1999. Average over 2-4 months FC (DJF). Blue bars correspond to a single model, and red to a multi-model.*

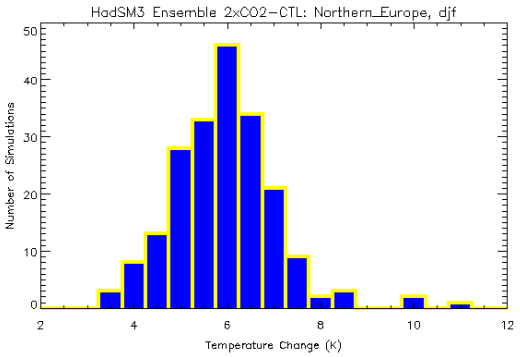

Figure 2: *Winter (DJF) warming over Northern Europe under doubling CO_2 conditions.*

RT2A: Production of seasonal to decadal hindcasts and climate change scenarios

A mailing list (ensembles_rt2a@meteo.fr) has been established for facilitating contacts between the participants to RT2A. A web site has been set up for the sharing and dissemination of relevant information.

The modelling groups have discussed and determined a common number of forcing factors to be used in the simulations, which will also be consistent with the IPCC scenarios. Moreover, it has been decided to perform a pre-industrial control simulation with the observed concentration of year 1860 to compute the equilibrium climate for each model, and subsequently to perform the first set of simulations over the period 1860-2000 using the observed evolution of greenhouse gases and sulphur aerosols over this period, while keeping fixed solar and volcanic forcings for consistency with the 21st century simulations.

A common set of greenhouse gas concentrations, based on historical observations for the period 1860-2000 and on the 3 IPCC SRES scenarios A2, A1B and B2 for 2000-2100, has been assembled and made available on the project web site for the simulation of each scenario. A list of recommended variables is decided to be stored during the simulations. The list was circulated among other working groups for further comments and suggestions. All the modelling groups have started their simulations, and some have already completed them.

Seasonal to decadal prediction activities for RT2A have started in close coordination with activities planned for RT1 and discussions took place with respect to the design of experiments, production of ocean initial conditions, methods of ensembles generation.

A mailing list for cross-RT discussions on seasonal to decadal themes has been set up (ensembles_s2d@cerfacs.fr). With the end of the ENACT project, recent sets of ocean reanalyses over 40 years have been produced that will be used in the seasonal to decadal studies. Some pre-production of seasonal hindcast ensembles has started, based on pre-existing systems developed in DEMETER.

In the next few months, the different modelling groups aim to complete their simulations, process their results to compute suitable statistics, and start making them available on web-servers. Based on their previous experience MPIMET.MD and ECMWF will identify the list of ocean and atmospheric variables to be archived in their archiving systems, with a definition of the formats in which data and metadata will have to be delivered for storage and distribution. Solar and volcanic forcings over the periods 1860-2000 will be chosen for performing a set of multi-model coupled simulations including also estimations of all the anthropogenic forcings over this period. A joint meeting of RT2A and RT1 will take place in Toulouse from 13-15 June 2005.

RT2B: Production of Regional Climate Scenarios for Impact Assessments

RT2B forms Part II of the ENSEMBLES Model Engine. Its principal aim is to construct and analyse probabilistic high-resolution regional climate scenarios and seasonal-to-decadal hindcasts. It thus provides a vital link in the ensemble modelling system between ESM output from RT1 and RT2A and the RCMs developed in RT3, and the impacts assessments to be carried out in RT6.

RT2B is dependent on inputs from other RTs (in particular, RT2A and RT3), as well as providing inputs to other RTs (in particular, RT6). Thus RT2B work will be concentrated in project years 3 and 4. However, many decisions which impact upon the RT2B work have to be taken at an early stage of ENSEMBLES and thus RT2B participants are contributing to various discussions that are underway. RT2B has, for example, provided information to RT2A and RT3 about the GCM and RCM model outputs required. Partners are also contributing towards ongoing discussions with RT3 concerning the domain, forcing and other aspects of the planned RCM simulations.

These discussions will also inform one of the first RT2B deliverables – the experimental plan for the 20 km RCM climate change simulations to be run in year 3. It is evident that considerable thought needs to be given to drawing up this plan – balancing aspects such as model resolution, domain, length and number of runs and the desire to sample a large number of GCM forcing and emissions scenarios. Currently several short test simulations on different domains are carried out and will be analysed during the next few weeks. Thus more detailed discussions will be held in January and February 2005 before completing this deliverable by the end of month 6.

Links with RT6 are particularly important for RT2B and it is anticipated that the first ENSEMBLES cross-cutting workshop on 'Impacts studies and climate model outputs: synergies and challenges' will provide a valuable opportunity for developing these links. Two of the RT2B/RT6 co-ordinators (Clare Goodess and Andy Morse) have provided assistance to Martin Beniston of RT8 in drawing up the programme for this workshop. Discussions at this workshop will provide a good basis for the technical specification of the regional climate scenario construction work to be undertaken in RT2B (a deliverable due at the end of year 1).

One issue, which emerged from the ENSEMBLES kick-off meeting, is the need to integrate work on seasonal-to-decadal timescales into RT2B. As a first step towards this, Clare Goodess is planning a visit to ECMWF in February 2005.

RT3: Formulation of very high resolution Regional Climate Model Ensembles for Europe

In ENSEMBLES, RT3 addresses formulation of very high resolution Regional Climate Model Ensembles for Europe. Compared to earlier efforts on regional climate modelling, such as the recent PRUDENCE-project (EVK2-CT2001-000132), RT3 considerably extends regional model evaluation and introduces formal intra-model performance measures. These measures will then be applied to construct a multi-member regional climate model ensemble system for Europe, to be used for transient regional scenarios at 20 km resolution by RT2B.

Currently, RT3 works on its common experimental set-up. This is to be finalised by early 2005. Efforts are made to define in detail the modelling domain. It should cover all of Europe, without becoming so large that the computational cost becomes prohibitive (Figure 3). A large regional domain is a challenge also in the sense that it might allow large-scale deviations from the global model simulations that provide boundary forcing. At the same time, a common data archiving specification is being agreed on, co-ordinated with many of the other RTs of ENSEMBLES, such as RT2B, RT5 and RT6. During 2005-2006, RT3 will address the intra-model performance issue with a suite of regional climate model experiments based on the ERA-40 global reanalyses. The ensemble regional climate model system will thereafter be provided to RT2B and finalised during the third project year.

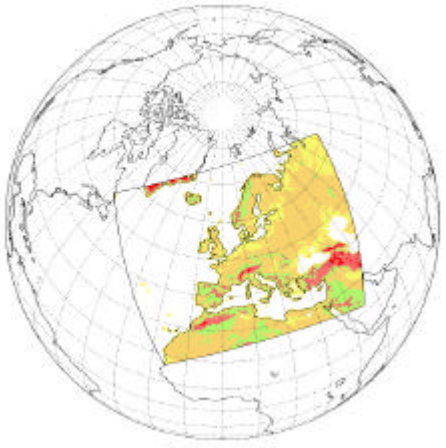

Figure 3: *The maximum RT3 regional modelling area covering all of Europe. Efforts are underway to test the feasibility of this domain, in terms of model performance, biases and computational constraints. The final RT3 regional modelling domain will probably be somewhat smaller.*

RT4: Understanding the processes governing climate variability and change, climate predictability and the probability of extreme events

Uncertainty in climate sensitivity has not decreased between the second (1995) and the third (2001) assessment report of the IPCC (see figure 4), despite a considerable international effort. Some climate processes are better understood, but the uncertainty of some critical processes (such as water and cloud feedback) has not decreased and adding some previously neglected processes (such as carbon climate feedbacks) has added to the uncertainty. This research theme will increase our confidence in climate change predictions (i) by contributing to the understanding of the key processes that govern climate sensitivity and climate predictability and (ii) by exploring dramatic possible events or new possible feedbacks. We will focus on the water vapour and cloud feedbacks; the climate-carbon cycle feedback (with a specific focus on terrestrial carbon cycle sensitivity to climate change) and we will explore the risks of abrupt climate change due to feedbacks at high latitudes (involving snow, sea-ice and the thermohaline circulation). We will also quantify which part of climate sensitivity uncertainty is due to limitation of climate predictability.

In order to consider the impact of climate change at local scales, an important step is to characterise the climate variability and the meteorological extreme events, and how they change with climate change. The characteristics of global and regional modes of variability will be analysed in global climate models. The relationships between modes of large-scale, low frequency variability and variability on shorter time and space scales will be investigated. The factors controlling extreme events will then be investigated.

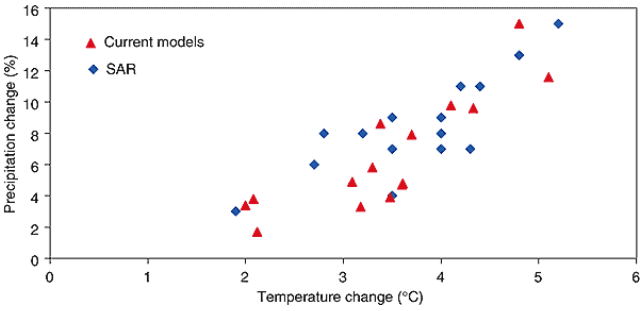

Figure 4: *Equilibrium climate and hydrological sensitivities from atmospheric general circulation models coupled to mixed-layer ocean components; blue diamonds from the SAR [IPCC-1995], red triangles from TAR [IPCC-2001]*

RT5: Independent comprehensive evaluation of the ENSEMBLES simulation-prediction system against observations/ analyses

Initial condition and perturbed physics ensembles will be run by the climateprediction.net experiment as part of Ensembles. This allows scientists to investigate climates which are observationally realistic, but which have not been modelled by traditional approaches. Figure 5 shows the evolution of

global mean temperatures over time for the climateprediction.net (black) and QUMP (red) ensembles. Both ensembles access a wide range of sensitivities for models, which are reasonably consistent with recent observations

RT6: Assessments of impacts of climate change

The initial activity of WP6.1 is to construct working global "off-line" models of the terrestrial biosphere that include generic crops (with the ability to

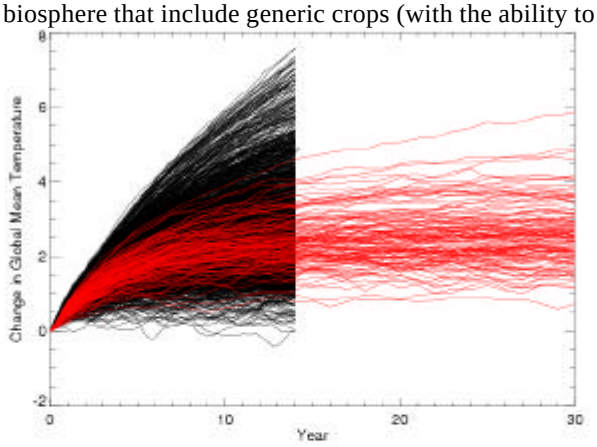

***Figure 5**: Evolution of global mean temperatures over time for the climateprediction.net (black) and QUMP (red) ensembles.*

simulate yields as well as biophysical properties) and at least for the LPJ model - also a scheme to represent forest management. There will be a QUEST international workshop held at Rothamsted, UK, in March 2005, including the WP6.1 participants, as well as others from beyond Europe. This workshop will help us to make good progress towards our near-term ENSEMBLES goals by comparing notes and sharing ideas among the different modelling groups.

Current progress and plans of WP6.2 of ENSEMBLES for the first 12 months are as follows: FMI have started to collect soil moisture and soil temperature data that will be used for validation of soil parameterisations. A soil model known as COUP has been installed and model runs have been made for the simulations of conditions in Lapland in northern Finland. The aim has been to examine how the type of vegetation (tundra versus boreal forest) influences on snow cover, soil temperature and soil moisture and what are the possible feedbacks between surface and atmosphere.

NOA are using observational station data to assist in the construction of an energy impact model (deliverable D6.3). Data used for the model construction are temperature and energy load in the greater Athens area in Greece. The model construction is still in its early stages but it is anticipated that we will be able to make future energy load projections when model data is available and also examine the applicability of the model in other European locations, either in the south or in the north of Europe.

During months 7-12 DIAS will collect the necessary data on climate, crops and crop management to be used for setting up and testing the Daisy soil-plant-atmosphere model for sites across Europe. FMI aims to study the maximum amount of damage that could be caused by a plausible future storm on boreal forest. The test area will be in eastern Finland and the work will be done together with the University of Joensuu. During the coming months they plan to finalise the study of the influence of the "worst case scenario" on wind damage on forests and also plan to start to write a report/article about this subject. The testing of COUP model will continue. Some new simulations will be made and a manuscript will be submitted based partly on simulations made using COUP and partly based on measurements made in Lapland.

Other partners will begin to test and calibrate a number of different impact models, for example, models of crop potential, crop production systems, grapevine, olive, a storm damage model (for wind), a fire weather index and several hydrological models. Some models will be used to identify critical thresholds of impact, by undertaking multiple simulations across a range of plausible changes in different driving climate variables and constructing response surfaces. Other models are being deployed specifically to examine the impacts of changes in climate variability and extremes. Both sets of models will be used in conjunction with probabilistic scenarios in order to explore changing risk of impacts. Thresholds of impact may also be identified using information about historical events (e.g. floods and droughts).

The single deliverable by month 12 is "*Completion of data collection for calibration and testing of impact models and as reference data for model data. Delivery of data*". A research theme meeting is being planned for June 2005 at which there will be discussion of progress in model testing, and of approaches for applying probabilistic scenarios to evaluate risk.

WP6.3 have been active in discussions with the GCM, RCM and seasonal to decadal modelling groups regarding variables to archive and archiving intervals. The RT6 website has gone live and is starting to be developed although most of this work will take place in 2005. The majority of the groups will not start funded activity until part way through 2005 but the permanent staff in the partner organisations have been working on preparations to allow an easy and quick start up to the project, once research posts are filled. These staff are also starting to represent the project through ongoing meetings and conferences.

RT7: Scenarios and Policy Implications

Information on RT7 will be included in a future Newsletter.

RT8: Dissemination, Education, and Training

As noted in the project summary, within the responsibilities of RT8 is mainly the dissemination of the results emerging from the ENSEMBLES research community. At this early stage of the project, the current newsletter contributes towards this aim, by allowing efficient dissemination and exchange of information regarding the status of the current research and the plans for future research activities, within the ENSEMBLES framework. One of the primary objectives of RT8 is to organize Workshops and thus to provide an adequate framework for ENSEMBLES partners to interact both within the community and with end-users and stakeholders.

Therefore, the RT8 team has started organizing the first ENSEMBLES Workshop, which is entitled "Impacts studies and climate model outputs: synergies and challenges". The Workshop will be held in Evora, Portugal, from May 9-11, 2005. The Workshop aims to bridge the gap between the climate modelling community, those working in climate scenario development, and a range of end-users in the climate-impacts realms, and to find solutions to the numerous problems that past research has to date not completely solved. A first draft programme is already provided in the RT8 website (http://www.unifr.ch/geoscience/geographie/ENSEMBLES/rt8/evora.html). Further announcements will follow in January and February, including details on venue and local accommodation, and transportation from Lisbon to Evora. A final program will be ready by early April 2005.