

# *Ensembles-Based Predictions of Climate Changes and Their Impacts (ENSEMBLES)*



*ENSEMBLES Technical Report No. 1*

**C. D. Hewitt and D. J. Griggs**

**November 2004**



ISSN 1752-2854

# **Ensembles-Based Predictions of Climate Changes and Their Impacts (ENSEMBLES)**

**C. D. Hewitt and D. J. Griggs**

**Met Office, Fitzroy Road, Exeter EX1 3PB, UK**

## **Abstract**

The ENSEMBLES project will develop an ensemble climate forecast system for use across a range of timescales (seasonal, decadal and longer) and spatial scales (global, regional and local). The model system will be evaluated by making hindcasts for the 20<sup>th</sup> Century, which will be compared against quality-controlled, high-resolution datasets for Europe. The model system will then be used to construct probabilistic scenarios of future climate change and climate variability for quantitative risk assessments, to provide policy-relevant information on climate change and its interactions with society. Emphasis will be placed on changes in extreme events (such as the severity and frequency of heat waves, storms, floods and drought), and the effects of high-impact but low-probability events. The five-year project started in 2004 and is a major undertaking by more than 60 institutes from 20 countries, mainly in Europe. It is coordinated by the Hadley Centre at the Met Office in the UK, and is funded under the European Commission's 6th Framework Programme. Here we provide an overview of the project.

## **Introduction**

Predictions of natural climate variability and the human impact on climate are inherently probabilistic, due to uncertainties in the initial conditions of forecasts, the representation of key processes within models, and climatic forcing factors. Hence, reliable estimates of climatic risk can be made only through ensemble integrations of Earth system models in which these uncertainties are explicitly incorporated.

The ENSEMBLES project, funded through a 5-year contract with the European Commission, aims to provide probabilistic estimates of climatic risk through ensemble integrations of Earth system models in which the uncertainties noted here are explicitly incorporated.

The project, funded since 1 September 2004 under the Commission's Sixth Framework Program, is a major undertaking among a large number of mainly European institutions. The project has 69 partners, and is being coordinated by the Hadley Centre at the Met Office in the UK.

The project will, for the first time, develop a common ensemble climate forecast system for use across a range of timescales (seasonal, decadal, and longer) and spatial scales (global, regional, and local). This model system will be used to construct integrated scenarios of future climate change, including non-intervention and stabilization scenarios that will provide a basis for quantitative risk assessment of climate change and climate variability. There will be an emphasis on changes in extremes, including changes in storminess and precipitation and the severity and frequency of

drought, and the effects of “surprises,” such as the shutdown of the thermohaline circulation.

An important component of the project will be to extensively validate the model system. Hindcasts made by the model system for the twentieth century will be compared against quality-controlled, high-resolution gridded data sets for Europe. Probability forecasts made with the model system on seasonal and decadal timescales will also be validated against existing data. The exploitation of the results will be maximized by linking the outputs of the ensemble prediction system to a wide range of applications (for example, agriculture and health). In turn, feedback from these impact areas to the climate system will also be addressed.

About 110 participants attended a “kick-off meeting” held recently in Hamburg, Germany. During Day 1, a plenary provided an overview of the project and its objectives, and was followed by discussions of the project’s research themes. Day 2 began with multiple breakout groups to discuss the research themes, and was followed by combined groups discussing the linkages across the project, and ended with a summarizing session in plenary.

## **The Research Themes of the ENSEMBLES Project**

The project plans to bring together a broad spectrum of international expertise across many disciplines to provide policy-relevant information on climate and climate change and its interactions with society. To meet the goals of the project, the work will be carried out in 10 closely connected research themes covering the following activities, which were presented during the plenary discussions:

- Provision of overall coordination of the project to ensure that the project is well integrated, managed, and promoted (RT0);
- Development of the global ensemble prediction system based on global Earth system models developed in Europe (RT1);
- Production of sets of simulations at seasonal-decadal, and centennial timescales using the global ensemble prediction system (RT2A);
- Production of regional climate scenarios for impacts assessments, using a high-resolution regional climate model (RCM) ensemble system and downscaling methods to add value to the global ensemble prediction system (RT2B);
- Development of the high-resolution RCM ensemble system for Europe and a third-world region (RT3);
- Advancement of our understanding of the basic science issues, focusing on the processes governing climate variability and change, climate predictability, and the probability of extreme events (RT4);
- Independent, comprehensive evaluation of the ENSEMBLES simulations against observations and analyses (RT5);
- Assessments of the effects of climate change by integrating process models of impacts on the global environment into Earth system models, linking impact models to probabilistic scenarios of climate change, and maximizing skill in the impact models at seasonal-decadal timescales (RT6);
- Adoption of scenarios of greenhouse gas emissions, land-use change, and adaptive capacity with and without greenhouse gas emission reduction policies, and testing the sensitivity of these scenarios to climatic change (RT7);

- Provision of support to the ENSEMBLES community in the dissemination of results emerging from the other research themes and from the project as a whole, along with education and training through short courses and exchange programs (RT8).

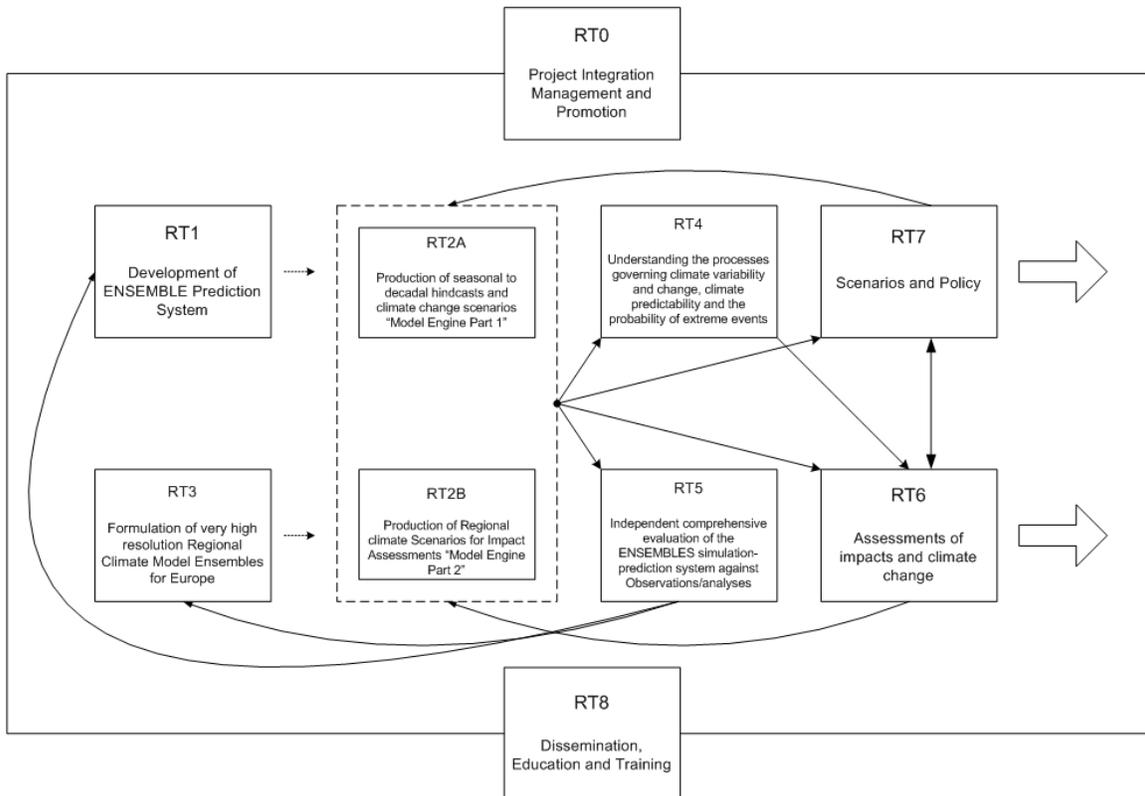


Figure 1 Linkages among the different research themes (RTs).

## Linkages among Research Themes

To enable the project to meet its objectives, it is essential that the research themes are linked together. The main linkages were discussed in breakout groups, and are shown in Figure 1. The global and regional climate model ensemble prediction systems developed in themes 1 and 3 will be used to produce seasonal-decadal hindcasts and climate change scenarios in themes 2A and 2B, using emissions and land-use scenarios from theme 7, for the assessment of the impacts of climate change in theme 6. Theme 7 will also take the first steps toward the integration of the human dimension into the Earth system models. The model results will be analyzed to increase our understanding of the processes and feedbacks in theme 4, and will be evaluated against observations and analyses in theme 5. Knowledge gained from all these activities will subsequently guide improvements in the ensemble prediction system and will be disseminated to the scientific community, the public, and the stakeholder community through theme 8.

In summary, the ENSEMBLES project aims to provide probabilistic estimates of climatic risk through ensemble integrations of Earth system models, and will do this by:

- Developing an ensemble prediction system based on global and regional Earth system models, validated against quality-controlled, high-resolution gridded data sets for Europe;
- Quantifying and reducing the uncertainty in the representation of physical, chemical, biological, and human-related feedbacks in the Earth system (including water resource, land-use, and air quality issues, and carbon cycle feedbacks);
- Maximizing the exploitation of the results by linking the outputs of the ensemble prediction system to a range of applications, including agriculture, health, food security, energy, water resources, insurance, and weather risk management.

More information on the project is available at <http://www.ensembles-eu.org> or from the project coordinator at [ensemblesfp6@metoffice.gov.uk](mailto:ensemblesfp6@metoffice.gov.uk). The Kick-off Meeting was held 15–16 September 2004, at the Max Planck Institute for Meteorology, in Hamburg, Germany.

## **Acknowledgments**

Support for the kick-off meeting was provided by the European Commission's Sixth Framework Program and the local organizing committee at the Max Planck Institute for Meteorology, in Hamburg.

The coordinators of the research themes form the ENSEMBLES Management Board, the decision-making body for the project. The current coordinators are Dave Griggs (RT0); James Murphy and Tim Palmer (RT1); Jean-Francois Royer and Guy Brasseur (RT2A); Clare Goodess and Daniela Jacob (RT2B); Jens Christensen and Markku Rummukainen (RT3); Julia Slingo and Hervé le Treut (RT4); Antonio Navarra and Albert Klein Tank (RT5); Andy Morse and Colin Prentice (RT6); Richard Tol and Roberto Roson (RT7); and Martin Beniston and Christos Giannakopoulos (RT8); assisted by Chris Hewitt (ENSEMBLES director) and Georgios Amanatidis (project officer at the European Commission).

An edited version of this paper was published by AGU, citation: PAGE 566, *Eos*, Vol. 85, No. 52, 28 December 2004