8.5 Deliverables list

Del. No.	Deliverable name	WP no.	Lead participant	Estimated indicative	Nature [1]	Dissemi-nation level [2]	Delivery date [3]
1.11	Scientific report/paper documenting the improved seasonal hindcast skill of the ECHAM5/OM1 coupled model in the ENSEMBLES	1.5	IfM	3	R	PU	42
1.12	A report/publication comparing the Oxford and Hadley Centre methods for obtaining probabilistic	1.2	UOXFDC	12	R	PU	42
1.13	Scientific report/paper documenting the seasonal hindcast skill of the most	1.2	ECMWF	6	R	PU	42
1.14	A comparison of perturbed physics ensembles	1.6	FUB	10	R	PU	54
1.15	Report describing improved probabilistic predictions of 21st century climate over Europe, obtained by combining global model Hadley Centre perturbed physics ensemble results, multi-model ensemble results, and observational constraints.	1.2	METO-HC	8	R	PU	57

[1] Please indicate the nature of the deliverable (**R**=report, **P**=prototype, **D**=demonstrator, **O**=other)
[2] Please indicate the dissemination level (**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 member of the consortium including the Commission Services
[3] Month in which deliverables will be available. Month 1 marking the start of the project, and all delivery dates being relative to this start date.

Del. No.	Deliverable name	WP no.	Lead participant	Estimated indicative	Nature [1]	Dissemi-nation level [2]	Delivery date [3]
1.16	Assessment of relationships between errors in seasonal to decadal hindcasts and longer term climate predictions,	1.5	METO-HC	10	R	PU	57
1.17	Updated comparison of the multi-model, perturbed physical parameters and stochastic physics approaches to tackle model uncertainties in the seasonal-to-decadal hindcasts	1.2	ECMWF	6	R	PU	60
1.18	Forecast quality assessment found in perturbed physics ensembles using the DePreSys system	1.5/ 5.3	ECMWF	2	R	PU	60
	of the seasonal-to-decadal Stream 2 hindcasts attempt to combine the three methodologies into one system accounting for model error						

8.6 Work package description (24 months period, month 37-60)

Work package number	1.0	**Start date or starting event:**	Month 37
Activity Type[4]	RTD		
Participant id	1 (METO-HC), 5 (ECMWF), 70 (UOXFDC), 10 (MPIMET)		
Funded/unfunded Person-months	METO-HC (1/1), ECMWF (1/0), UOXFDC (0/0), MPIMET (0/0)		

Objectives

Provide management and coordination of activities within RT1.

Description of work

WP1.0: Management of RT1

Task 1.0.2: The RT1 website will be maintained and developed, containing information such as location of model documentation, model output data, contact details, progress reports, summaries of meetings and key scientific developments etc.

Task 1.0.3: Timely delivery of milestones, deliverables and progress reports and representation of RT1 at ENSEMBLES management meetings will be ensured.

Task 1.0.7: The RT1 management team will coordinate contributions from the RT1 workpackages to ensure delivery of Major Milestone MM1.3, "Specification of a "second generation" ensemble prediction system (Version 2)". This will review results from our ensemble projection experiments for seasonal to decadal and longer timescales, and from techniques developed to convert these into expressions of uncertainty in climate predictions, in order to recommend a specification for an improved climate prediction system.

Task 1.0.8: Contributions from RT1 to cross-cutting activities in ENSEMBLES will be encouraged and supported as required, including workshops at General Assemblies, provision of results and advice in support of users of our ensemble global climate simulations, and contributions to the conference and publications planned to showcase the final results from the project in 2009.

Deliverables

Milestones[5] **and expected result**

Work package number	1.1	**Start date or starting event:**	Month 37
Activity Type	RTD		

[4] For Integrated Projects each workpackage must relate to one (and only one) of the following four possible Activity Types: RTD/Innovation activities, Demonstration activities, Training activities, Management activities

[5] Milestones are points where major results have successfully been achieved as the basis for the next phase of work, or 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.

Participant id	1 (METO-HC), 3 (CNRS) 4 (DMI), 7 (INGV) 10 (MPIMET)	
Funded/unfunded Person-months		

Objectives

Provision of Earth System models constructed from available component modules and available for ensemble prediction system.

Description of work

The work of WP1.1 has now been completed.

Deliverables

Milestones and expected result

Work package number	1.2	**Start date or starting event:**	Month 37
Activity Type	RTD		
Participant id	1 (METO-HC), 5 (ECMWF), 70 (UOXFDC), 38 (FUB), 49 (LSE), 8 (KNMI), 4 (DMI), 45 (IRI)		
Funded/unfunded Person-months	METO-HC (4/4), ECMWF (9/3), UOXFDC (6/0), FUB (1.5/0), LSE (0/0), DMI (0/0), IRI (0/0)		

Objectives

Develop techniques for the representation of modelling uncertainties in ensemble predictions.

Description of work

WP1.2: Developing and testing schemes to represent model uncertainty in seasonal to centennial prediction.

Task 1.2.11: The implementation of a Bayesian technique for generating probabilistic predictions from small ensembles of complex model simulations will be completed. The perturbed parameter experiments run under WP1.6 will be used, together with a number of statistical and reduced-

complexity models, to produce PDFs of future changes at 300km-grid-scale for the European region. The PDFs will be conditional on the SRES A1B Scenario and expert prior assumptions for parameter ranges, will use emulation techniques to explore untried regions of parameter space, will use likelihood weighting based on time-mean observations and historical trends and will utilise multi-model output from ENSEMBLES and elsewhere to estimate a discrepancy term that accounts for the effects of structural model errors.

Task 1.2.12: Oxford will continue development of a methodology for probabilistic climate forecasting which seeks to minimise model bias and maximise the dependence of the forecast distribution on the data used to constrain it. This will feed into a report comparing the different methodologies developed by the Hadley Centre and Oxford (D1.12).

Task 1.2.13: A scientific paper on the seasonal hindcast skill of the new ECMWF stochastic physics scheme will be produced based on results from the stream 1 hindcasts. The scheme uses a Cellular Automaton Stochastic BackScatter (CASBS) approach. The paper will focus on both the impact of CASBS on systematic errors and on the impact of the skill in seasonal hindcasts.

Task 1.2.14: A new set of the stream 1 seasonal-to-decadal hindcasts will be produced with the latest version of the stochastic physics scheme being currently developed at ECMWF for applications in the medium-range. This scheme is now based on a SPectral BackScatter (SPBS) approach which uses a spectral Markov chain to generate the spatial pattern of backscatter of energy. The quality of these new simulations will be analysed and compared with the previous CASBS runs and with the other two approaches to tackle model uncertainty (multi-model and perturbed physics ensembles).

Task 1.2.15: An updated assessment of the performance on seasonal-to-decadal timescales of the multi-model, perturbed physical parameters and stochastic physics ensembles will be provided based on the latest set of hindcast experiments. Eventually, this will lead to some preliminary analysis of how the three individual approaches could be statistically combined into a 'grande model-error sampling ensemble'. Work will be needed to be carried out to test ways how to best weight and combine the different systems. This will partly be done using the em-tool software for ensemble interpretation methods developed by LSE. Other methods we are going to apply are principle component linear regression and calibration/combination based on conditional exceedance probabilities.

Task 1.2.17: A way of using weighting methods for the EGMAM perturbed physics ensemble simulations (see WP1.6, task 1.6.9), developed by project partners (LSE), will be investigated and implemented for the analysis of the perturbed physics experiments.

Task 1.2.18: The question of how a general framework for a multi-model, perturbed physics ensemble system should be designed will be investigated, in order to provide recommendations for future work (month 60, Major Milestone 1.3).

Deliverables

D1.12: A report/publication comparing the Oxford and Hadley Centre methods for obtaining probabilistic forecasts from perturbed parameter ensembles.

D1.13: Scientific report/paper documenting the seasonal hindcast skill of the most recent version of the stochastic physics scheme developed at ECMWF.

D1.15: Report describing improved probabilistic predictions of 21st century climate over Europe, obtained by combining global model Hadley Centre perturbed physics ensemble results, multi-model ensemble results, and observational constraints.

D1.17: Updated comparison of the multi-model, perturbed physical parameters and stochastic physics approaches to tackle model uncertainties in the seasonal-to decadal hindcasts and first attempt to combine the three methodologies into one system accounting for model error.

Milestones and expected result

MM1.3: Specification of a "second generation" ensemble prediction system (Version 2). Month 60

Work package number	1.3	**Start date or starting event:**	37
Activity Type			
Participant id	1 (METO-HC), 5 (ECMWF), 43 (IfM) , 8 (KNMI), 3 (CNRS-IPSL), 20 (CERFACS), 7 (INGV)		
Funded/unfunded Person-months			

Objectives

Techniques for representation of initial condition uncertainties in ensemble predictions.
Improved methods of initialising the ocean module for seasonal to decadal predictions.

Description of work

The work of WP1.3 is now completed.

Deliverables

Milestones and expected result

Work package number	WP1.4	**Start date or starting event:**	37
Activity Type	RTD		
Participant id	1 (METO-HC), 2 (CNRM), 3 (IPSL-CNRS), 5 (ECMWF), 7 (INGV), 20 (CERFACS), 43 (IfM), 49 (LSE)		
Funded/unfunded Person-months	METO-HC (4/4), CNRM (0/0), IPSL-CNRS (0/0), ECMWF (6/0), INGV (0.5/0.5), CERFACS (0/0), IfM (1/0), LSE(0/0)		

Objectives

Assembly of a multi-model prediction system.

Description of work

WP1.4: Assembly of a multi-model ensemble system, with common output, with installation on a single supercomputer, where appropriate.

Task 1.4.7: Progress on the development of the stochastic physics scheme at ECMWF (WP1.2, Task 1.2.9) will be transferred to the forecast system. The design of the experiments will follow the pre-production simulations as defined in WP1.5 (5-year Task 1.4a).
Task 1.4.8: IfM will optimize the archival of their hindcast data and contribute to the development of diagnostics for decadal hindcasts (5-year Tasks 1.4a and 1.4b).
Task 1.4.9: CERFACS will work on ocean and sea-ice initialisation procedures for the ARPEGE-NEMO coupled model (to be used in the production of stream 2 decadal hindcasts) to allow starting the simulations using ocean analyses produced in WP1.3 with a previous version of OPA.
Task 1.4.10: INGV will install and test at ECMWF the procedures to archive the Stream 2 seasonal to annual ensemble hindcasts, already implemented at INGV (5-year Task 1.4b).

Deliverables

Milestones and expected result

M1.8: Completion of the seasonal-to-decadal Stream 2 hindcasts, WP1.4/WP1.5/WP2A.1, month 48, Institutions: ECMWF, METO-HC, CNRM, INGV, IfM, CERFACS

Work package number	WP1.5	**Start date or starting event:**	37
Activity Type	RTD		
Participant id	1 (METO-HC), 2 (CNRM), 5 (ECMWF), 7 (INGV), 20 (CERFACS), 43 (IfM)		
Funded/unfunded Person-months	METO-HC (11/11), ECMWF (2/0), CNRM (0/0), IfM (10/0), CERFACS (0/0), INGV (1.5/3.5)		

Objectives

Test methodologies for probabilistic climate prediction on seasonal to decadal time scales accounting for modelling and initial condition uncertainties in ensemble predictions.

Description of work

WP1.5: Generation of pre-production ensemble predictions of climate on the seasonal to decadal timescale, initialised from observations.

Task 1.5.4: Additional contributions to the Stream 1 seasonal and decadal-timescale ensemble integrations will be made using a) part of the multi-model ensemble system (IFS/HOPE, GloSea, ECHAM5/OM1), b) the perturbed parameter system, c) the stochastic physics system. The IFS/HOPE (ECMWF) contribution will allow the testing of the new versions of the stochastic physics scheme based on spectral backscatter mechanism of energy and the impact of the coupling (by running the atmospheric model with observed sea surface temperatures). IfM will investigate with ECHAM5/OM1 alternative methods for ensemble member generation, using singular vector techniques, along with the impact of systematic errors on forecast skill by performing forecasts with a hierarchy of flux-correction schemes. In addition, IfM will perform a set of decadal ensemble hindcasts using improved ocean initial conditions, generated from coupled SST anomaly runs as well as a set of seasonal-to-decadal ensemble hindcasts using the ensemble Kalman filter (EnKF) scheme provided by KNMI in WP1.3. All these integrations will be carried out using a design

similar to that chosen for the stream 1 experiments (5-year Task 1.5a).
Task 1.5.5: The forecast quality of the Stream 1 simulations and the simulations described in Tasks 1.5.3 and 1.5.5 will be further assessed for each forecast system and for simple combinations of them using deterministic and probabilistic scores (5-year Tasks 1.5b and 1.5c).
Task 1.5.6: METO-HC will complete the task of producing further interannual to decadal hindcasts with their DePreSys perturbed parameter system (5-year Task 1.5a), started from the period 1960-2005, in parallel to the Stream 2 multi-model and stochastic physics simulations of WP2A.1. In addition, METO-HC will run their simulations from 1 November in each year out to a decade ahead, to provide a larger sample of decadal integrations for verification. They will also produce a parallel set of decadal experiments, using the same external forcings but started from initial states statistically independent of the observations. This will allow the impact of starting DePreSys from analyses of observations to be isolated.
Task 1.5.7: IfM will write a scientific article documenting the improved seasonal hindcast skill of the MPI model and the model improvements responsible for it (5-year Task 1.5b). This will be the deliverable D1.11.
Task 1.5.8: IfM, INGV and CNRM will contribute to the Stream 2 set of simulations with the experimental setup described in WP2A.1. Both INGV and CNRM will perform the seasonal and annual integrations, while IfM will carry out the whole set of seasonal-to-decadal hindcasts. This will allow the specification of a second generation ensemble prediction system. CERFACS, along with its activities in WP2A.1, will complete the Stream 2 decadal hindcasts and archive them at ECMWF. In addition, IfM will carry out case studies for 2005/06 and additional decadal hindcasts, depending on the results from WP1.3 to improving the SST initialization technique (5-year Task 1.5a).
Task 1.5.9: METO-HC will extend a subset of their DePreSys perturbed physics simulations (as described in Task 1.5.6) out to multidecadal timescales, to lead times of at least 30 years ahead. This will allow an assessment of prospects for "seamless" climate prediction, by assessing the extent to which hindcast verification on seasonal to decadal timescales may provide a constraint on longer term predictions (D1.16).This is an additional task to those programmed at the beginning of the project.
Task 1.5.10: An assessment of the Stream 2 seasonal-to-decadal hindcasts will be undertaken. Reliability will be estimated using the Brier Score decomposition for dichotomous events based on surface pressure, surface temperature, and precipitation. Additional probability scores based on Relative Operating Characteristic and Potential Economic Value will also be studied. Finally, an ensemble comprising the multi-model, stochastic physics and perturbed parameter forecast systems will be evaluated (5-year Tasks 1.5b and c).

Deliverables

D1.11: Scientific report/paper documenting the improved seasonal hindcast skill of the ECHAM5/OM1 coupled model between DEMETER and stream 1 and the model improvements responsible for it (month 42, leader IfM).
D1.16: Assessment of relationships between errors in seasonal to decadal hindcasts and longer term climate predictions, found in perturbed physics ensembles using the DePreSys system (month 57, leader METO-HC).
D1.18: Forecast quality assessment of the seasonal-to-decadal Stream 2 hindcasts (month 60, leader ECMWF).

Milestones and expected result

Work package number	1.6	Start date or starting event:	Month 37
Activity Type	RTD		
Participant id	1 (METO-HC), 70 (UOXFDC), 38 (FUB), 2 (CNRM)		
Funded/unfunded Person-months	METO-HC(8/8), UOXFDC (6/6), FUB (10/0)		

Objectives

Test methodologies for probabilistic climate prediction on centennial time scales accounting for uncertainties in different Earth System modules and variations in model reliability.

Description of work

WP1.6: Generation of pre-production ensemble predictions of climate on the century timescale, initialised from model initial conditions.

Task 1.6.7: A small ensemble of HadCM3C, the Hadley Centre model including an interactive carbon cycle, will be performed in which perturbations are made to key parameters in the terrestrial component of the scheme (all parameters controlling physical feedbacks in the atmosphere and ocean will remain fixed). Methods to produce an ensemble with parameters perturbed simultaneously in physical, chemical and biological components will be investigated. Should that prove possible, and should computer resources (unfunded in ENSEMBLES) be available, an ensemble of runs will be performed.

Task 1.6.8: Analysis of the HadCM3L coupled model ensemble developed and launched under climatepredction.net will be continued with a view to publishing first results. The database of climate simulations made available to the ENSEMBLES community will be maintained and updated.

Task 1.6.9: The integration of the EGMAM perturbed physics ensemble in the doubled CO_2 concentration state will be finished. A detailed analysis of the uncertainty in the climate sensitivity of EGMAM due to parameterisations in the cloud physics will be performed. This analysis will be based on the perturbed physics ensemble and will include a statistical analysis of the ensemble. A physical interpretation of the feedback processes which lead to the differences in climate sensitivity will be made as well. A comparison between perturbed physics experiments with EGMAM and similar experiments from the Met Office-Hadley Centre and the University of Oxford will be carried out. (month 54, D 1.14).

Deliverables

D1.14: A comparison of perturbed physics ensembles constructed with different models (FUB lead, month 54).

Milestones and expected result