8.5 Deliverables list

Del. No.	Deliverable name	WP no.	Lead participant	Estimated indicative person-months	Nature [1]	Dissemi-nation level [2]	Delivery date [3]
1.8	Updated assessment in terms of forecast quality and potential economic value of the relative merits of the multi-model approach, the perturbed parameter approach, and the stochastic physics approach, to representation of model uncertainty in seasonal to decadal forecasts.	1.5	ECMWF	10	R	PU	30
1.9	Report on the production of OPA/NEMO analyses and initial conditions for use in seasonal to decadal Stream 2 hindcasts.	1.3	CERFACS	6	R	PU	34
1.10	Set of hindcasts using the lagged average method and earlier start dates carried out with GloSea following the stream 1 setup	1.5	METO-HC	4	R	PU	36
1.11	Scientific report/paper documenting the improved seasonal hindcast skill of the ECHAM5/OM1 coupled model in the ENSEMBLES stream 1 simulations, relative to DEMETER, and the model improvements responsible.	1.5	IfM	3	R	PU	42
1.12	A report/publication comparing the Oxford and Hadley Centre methods for obtaining probabilistic climate forecasts from perturbed parameter ensembles.	1.2	UOXFDC	12	R	PU	42

[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 person-months	Nature [1]	Dissemi-nation level [2]	Delivery date [3]
1.13	Scientific report documenting the seasonal hindcast skill of the most recent version of the stochastic physics scheme developed at ECMWF	1.4	ECMWF	6	R	PU	42

8.6 Work package description (18 months period, month 25-42)

Work package number	1.0	**Start date or starting event:**	Month 25
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 1.0.5: A workshop for the seasonal to decadal partners of RT1 will be held in Barcelona, during June 2007, as part of a larger meeting of the CLIVAR Working Group on Seasonal to Interannual Prediction. This will expose the ENSEMBLES work to a wide international community of modellers and users, including downscaling and applications scientists.

Task 1.0.6: RT1 will contribute to a workshop in Paris during spring 2007, organised by RT4, and also including partners from RT2A and RT5. The purpose will be to address how the current understanding and evaluation of physical processes may help to constrain climate predictions, focusing mainly on the impacts of water vapour and cloud feedbacks.

Deliverables

Milestones[5] **and expected result**

M1.7: A workshop organized jointly with WGSIP (the CLIVAR Working Group on Seasonal to Interannual Prediction) will be held in Barcelona on the 4-8 June 2007 to gather scientists working on seasonal-to-decadal forecasting from different continents (month 36).

Work package number	1.1	**Start date or starting event:**	Month 25
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	3/3 (METO-HC), 0/0 (CNRS) 6/0 (DMI), 0/0 (INGV) 6/2 (MPIMET)	

Objectives

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

Description of work

Task 1.1.4: ESMs for multi-model ensembles. METO-HC will finalise the development and spin-up of HadGEM2-OA (physical system plus aerosol system) and HadCM3C (physical system plus sulphur cycle plus carbon cycle system), ready to start stream 2 simulations by early 2007. *[The use of HadCM3C in stream 2 centennial simulations, as well as the perturbed parameter ensemble studies in WP1.6 using the same model, should provide a consistent way of inferring ranges of uncertainty including carbon cycle system processes integrated with modelling uncertainties in other parts of the climate system.]*

Task 1.1.6: Modify ESMs where necessary for experiments with scenario boundary conditions proposed in RT2A for stream 2. Implementation of models on production machines for stream 2 centennial integrations

Deliverables

Milestones and expected result

M1.5: ESMs fully prepared for stream 2 centennial experiments including the physical system, aerosol system and carbon cycle system, dependent on partner (month 30).

Work package number	1.2	**Start date or starting event:**	Month 25
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 (3/3), ECMWF (7/2), UOXFDC (6/0), FUB (2/4), LSE (8/2), DMI (0/3), IRI (0/1)		

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.

WP1.2 activities will proceed with the aims of further developing alternative methods of sampling modelling uncertainties in ensemble climate prediction, and of weighting members of ensembles through comparison with the present climate state and/or historical climate changes, building on work carried out during months 1-25 (see D 1.2). Methods of combining different approaches (e.g. multi-model, perturbed parameter and stochastic parameterisation ensembles) will also be developed, since these may outperform any individual approach.

Task 1.2.4: The Hadley Centre will continue the implementation of the Bayesian technique for generating probabilistic predictions from small ensembles of complex model simulations. The experiments run under WP1.6 will be used, together with statistical and reduced-complexity models, to further refine the emulation technique to sample points in a wider model-parameter space for which simulations do not exist. The multi-model output will be utilised to produce a first implementation of the discrepancy term designed to take into account structural uncertainties.
Task 1.2.5: 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. Such "stable inferences from data" (STAID) forecasts are set up to minimise the effect on the forecast of the prior beliefs of the experimenter.
Task 1.2.6: Development of methods of comparing alternative methodologies (1.2.4, 1.2.5) so as to maximise the useful information in forecasts will be undertaken by the Hadley Centre and Oxford.
Task 1.2.7: The FUB will develop and test schemes to represent model uncertainties by perturbing selected parameters (cloud parametrization, stratospheric representation) of the EGMAM-model and by variations in the model components.
Task 1.2.8: At FUB a stochastic parametrization scheme will be developed for use in centennial predictions with EGMAM. The effects of stochastic parametrization schemes in centennial model runs will be analysed and compared with the effects of such schemes on different time scales. The ability of the technique to represent modelling uncertainties will be tested. Different methods to weight ensemble members in stream one simulations will be developed. In the project months 25 to 42 an evaluation of different methods for model weighting in multi-model centennial predictions will be provided. This will lead to a method for generating probability distribution functions from ensembles of simulations.
Task 1.2.9: To account for the effects of unresolved processes the latest version of the IFS/HOPE model (Cy30R1) will be run at ECMWF with and without stochastic perturbations for the stream 1 seasonal-to-decadal set of experiments. The Cellular Automaton Stochastic BackScattering (CASBS) scheme used here introduces streamfunction perturbations on the near-gridscale and is motivated by the notion that a fraction of the dissipated energy will scatter upscale and inject kinetic energy into the resolved flow. For this purpose a cellular automaton is utilised to generate a spatially and temporally correlated pattern which is weighted with to the flow-dependent dissipation rate from numerical dissipation and friction from deep convection and gravity/mountain wave drag. A new version of CASBS, version 1.2, will be used which incorporates a cosine weighting of the cellular automaton pattern that is different to previous CASBS versions. Furthermore, a different way of computing the dissipation from convection will be used, which is now based on mass-flux formulation.
Task 1.2.10: A simple weighting of models used for climate change experiments will be set up by DMI. This will be based on the ability of the individual Earth system models (run without flux adjustments) to simulate different aspects of the climatological annual cycle, which is the most

simple example of a forced climate signal where both the forcing and response is well known.

Deliverables

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

Milestones and expected result

Work package number	1.3	**Start date or starting event:**	25
Activity Type			
Participant id	1 (METO-HC), 5 (ECMWF), 43 (IfM) , 8 (KNMI), 3 (CNRS-IPSL), 20 (CERFACS), 7 (INGV)		
Funded/unfunded Person-months	METO-HC(1/1), ECMWF (0/0), IfM (5/0), KNMI (0/0), CNRS-IPSL (6/6), CERFACS (3/3), INGV (0/0)		

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

WP1.3: Initialisation procedures for ocean components based on observed states.

Task 1.3.4: Based on results from task 1.3.1 and WP1.5, a process will be designed for production of ensembles of ocean analyses suitable for seasonal to decadal hindcasts over the full ERA40 period. This design will feed the production of ocean analyses ensembles in WP1.3 and WP2A.1. In particular, during the period of this workplan,

- METO-HC will generate ocean lagged average-initialisation ensembles for comparison with the use of ocean initialisation approaches based on the use of wind stress perturbations (e.g. that used in DEMETER). This work will assist in the design of initialisation and hindcast strategy.
- CERFACS will generate ensembles of ocean analyses and initial conditions for Stream 2 hindcasts following the new perturbation technique developed in the first phase of ENSEMBLES.

Task 1.3.5: New methods will be investigated at IfM-GEOMAR for initialisation of the thermohaline circulation. The focus will be on using SST data, which has much better spatial and temporal coverage than other available ocean data. Based on results from coupled SST assimilation runs, IFM-GEOMAR will perform a new set of coupled initialisation runs in which anomalies are assimilated, instead of full SST. Later statistical relations may also be applied to reconstruct subsurface thermohaline variations. This will feed into deliverable D2A.1.2.

Deliverables

D1.9: Report on the production of OPA/NEMO analyses and initial conditions for Stream 2 for use in seasonal to decadal Stream 2 hindcasts.

Milestones and expected result

M1.6: Completion of the Stream 2 OPA/NEMO analyses and initial conditions (month 34).

Work package number	WP1.4	**Start date or starting event:**	25
Activity Type	RTD		
Participant id	1 (METO-HC), 5 (ECMWF), 2 (CNRM), 43 (IfM), 49 (LSE), 3 (CNRS-IPSL), 20 (CERFACS), 7 (INGV)		
Funded/unfunded Person-months	METO-HC (3/3), ECMWF (13/1), CNRM(0/0), IfM (3/0), LSE (3/1), CNRS-IPSL (6/6), CERFACS (2/2), INGV (2/2)		

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 1.4.6: METO-HC will port to ECMWF and test the next generation ESM (HadGEM) with improved forecast initialisation for seasonal and decadal prediction. The initialisation process may upset physical or dynamical balances between the components of the model, e.g. between the ocean or land and the atmosphere. The adjustment of the model to the initialisation will be explored with the aim of reducing such imbalances and hence improving retention of anomalies present in the initial conditions. This ESM also offers the possibility of performing stochastic physics experiments. The INGV seasonal forecasting system (already installed on the NEC at INGV) will be updated by implementing the latest version of the INGV coupled model, with improved surface physics. Furthermore, INGV will implement the procedure to archive the forecast outputs in the required format (5-year Task 1.4a).

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 already installed at ECMWF. 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, implement other methods for ensemble member generation based on sea surface temperature perturbations, and adapt the EnKF data assimilation scheme developed by KNMI in WP1.3 (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.

Deliverables

D1.13: Scientific report documenting the seasonal hindcast skill of the most recent version of the stochastic physics scheme developed at ECMWF; WP1.4; Leader ECMWF; Estimated person months 6; Nature R; Dissemination PU; Delivery month 42

Milestones and expected result

Work package number	WP1.5	**Start date or starting event:**	25
Activity Type	RTD		
Participant id	1 (METO-HC), 5 (ECMWF), 2 (CNRM), 43 (IfM), 20 (CERFACS)		
Funded/unfunded Person-months	METO-HC (8/8), ECMWF (2/0), CNRM (1.5/1.5), IfM (5/0), CERFACS (0/0), INGV (0/2)		

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 and the impact of the coupling (by running the atmospheric model with observed sea surface temperatures). The GloSea (METO-HC) contribution will check, following the development and results in WP1.3 and WP1.4, the impact of starting the ensemble using the lagged average method and assess the consistency of the ensemble by comparing the standard stream 1 simulations with ensembles started two weeks earlier. 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-adjustment 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 1.5.4 and 1.5.6 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 produce further interannual to decadal hindcasts with their DePreSys perturbed parameter system. Changes will be made to the initialisation procedure, based on experience gained from the stream 1 simulations. A set of hindcasts will then be produced, started from the period 1960-2005, in parallel to the multi-model and stochastic physics simulations. 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. These simulations will also significantly contribute to stream 2 (see WP2A.1).
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).
Task 1.5.8: IfM, INGV and CNRM will contribute to the stream 2 set of simulations as described in WP2A.1. In addition, case studies IfM will carry out to investigate the potential predictability of European warm summers (5-year Task 1.5a).

Deliverables

D1.10: Set of hindcasts using the lagged average method and earlier start dates carried out with GloSea following the stream 1 setup.
D1.11: Scientific report/paper documenting the improved seasonal hindcast skill of the ECHAM5/OM1 coupled model in the ENSEMBLES stream 1 simulations, relative to DEMETER, and the model improvements responsible.

Milestones and expected result

Work package number	1.6	**Start date or starting event:**	Month 25
Activity Type	RTD		
Participant id	1 (METO-HC), 70 (UOXFDC), 38 (FUB), 2 (CNRM)		
Funded/unfunded Person-months	METO-HC(6/6), UOXFDC (6/0), FUB (2/4), CNRM (4/4)		

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 1.6.4: Ensemble experiments will be performed to test the sensitivity of the rate of transient climate change to key parameters in the ocean component of the HadCM3 model. Perturbations will initially be made to single parameters in isolation but the validity of further ocean-parameter ensemble experiments will be assessed. A small ensemble of HadCM3 experiments with perturbations made to sulphur-cycle component parameters will be initiated. A version of HadCM3 with interactive carbon-cycle dynamics will be developed and the validity of a carbon-cycle parameter perturbation study assessed.
Task 1.6.5: Analysis will begin of the HadCM3L coupled model ensemble developed and launched under climatepredction.net during months 13-25. Different methods of analysing large ensembles will be tested, in particular, weighting ensemble members according to their simulation of past climate in order to produce uncertainty estimates of future climate change.
Task 1.6.6: The 30 member perturbed physics ensemble of EGMAM versions will be integrated with doubled present day CO_2 concentrations to allow an assessment of the uncertainty in the climate sensitivity of EGMAM. Results will be compared with the perturbed physics ensembles produced by other project partners. This will build towards the development of a multi-model, perturbed-physics ensemble forecasting system, which may be used to generate probability distribution functions of the multi-model ensembles in RT2A. CNRM will perform a small ensemble of climate simulations in order to explore the sensitivity of the climate response to different ocean initial conditions.

Deliverables

Milestones and expected result