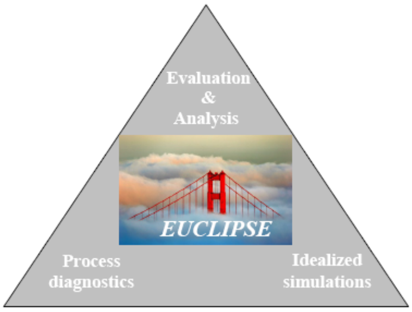
SEVENTH FRAMEWORK PROGRAMME

THEME I

Cooperation: Environment

Grant agreement for: **Collaborative Project**
(Small or medium-scale focused research project)

Annex I - "Description of Work"



Project acronym: **EUCLIPSE**

Project full title: **EU Cloud Intercomparison, Process Study & Evaluation Project**

Grant agreement no.: 244067

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Part A

A.1 Budget breakdown and project summary

A.1.1 Overall budget breakdown for the project

Budget breakdown

Participant number in this project [9]	Participant short name	Estimated eligible costs (whole duration of the project)					Total receipts	Requested EC contribution
		RTD / Innovation (A)	Demonstration (B)	Management (C)	Other (D)	Total A+B+C+D		
1	KNMI	625,000.00	0.00	241,000.00	30,000.00	896,000.00	0.00	706,000.00
2	MPG	566,000.00	0.00	3,000.00	0.00	569,000.00	0.00	427,000.00
3	METO	402,000.00	0.00	0.00	0.00	402,000.00	0.00	201,000.00
4	IPSL	598,400.00	0.00	4,000.00	0.00	602,400.00	0.00	452,000.00
5	AA	544,000.00	0.00	0.00	0.00	544,000.00	0.00	291,000.00
6	ECMWF	363,200.00	0.00	0.00	0.00	363,200.00	0.00	271,000.00
7	TUD	449,000.00	0.00	0.00	0.00	449,000.00	0.00	336,000.00
8	MF-CNRM	384,000.00	0.00	0.00	0.00	384,000.00	0.00	288,000.00
9	SU	164,800.00	0.00	0.00	0.00	164,800.00	0.00	123,000.00
10	ETH Zurich	107,200.00	0.00	0.00	0.00	107,200.00	0.00	80,000.00
11	UW	94,400.00	0.00	0.00	0.00	94,400.00	0.00	70,000.00
13	DKRZ	409,600.00	0.00	0.00	0.00	409,600.00	0.00	255,000.00
TOTAL		4,707,600.00	0.00	248,000.00	30,000.00	4,985,600.00	0.00	3,500,000.00

Note that the budget mentioned in this table is the total budget requested by the Beneficiary and associated Third Parties.

A.1.2 Project summary

Project summary

Cloud feedbacks in Earth System Models (ESMs) remain the largest source of uncertainty in projections of future climate. They are also a major contributor to uncertainty in other feedbacks (e.g., surface albedo, carbon cycle) in the Earth System. Through interactions with the large-scale circulation, cloud processes also contribute to synoptic circulations and regional climate. They are therefore critical to the prediction of future changes in precipitation patterns, climate variability and extreme events.

The central objective of EUCLIPSE is to reduce the uncertainty in the representation of cloud processes and feedbacks in the new generation of Earth System Models (ESMs), in support of the IPCC's fifth assessment report. Novel, process-oriented evaluations of clouds in present-day and future climate simulations made by the leading European ESMs will identify the cloud types and processes responsible for the spread in climate sensitivity and future precipitation changes across the models, and for deficiencies in the simulation of the present-day climate. The new diagnostics and metrics developed in EUCLIPSE will inform targeted sensitivity experiments to isolate the processes responsible for cloud feedback uncertainty.

In EUCLIPSE, four distinct communities will work together across a set of integrated work packages over a four-year period: the observational community will provide state-of-the-art measurements from ground- and space-based active and passive remote sensing; the numerical weather prediction community will provide analyses of short timescale model biases induced by cloud processes; the cloud modeling community will provide fine-scale models as an additional tool for understanding cloud behavior in a changing climate; finally, the climate modeling community will synthesize the physical understanding and observational constraints identified by the other communities to improve the representation and assessment of cloud processes in ESMs and so improve the predictive skill of ESMs.

Starting date of the project: 01-02-2010

A.1.3 List of beneficiaries

List of Beneficiaries

Beneficiary Number	Beneficiary name	Beneficiary short name	Country	Date enter project**	Date exit project
1 (coord.)	Royal Netherlands Meteorological Institute	KNMI	NL	month 1	month 54
2	Max Planck Institute for Meteorology	MPG	DE	month 1	month 54
3	Met Office	METO	UK	month 1	month 54
4	Centre National de la Recherche Scientifique – Institute Pierre Simon Laplace	CNRS-IPSL	FR	month 1	month 54
5	Academy of Athens	AA	GR	month 1	month 54
6	European Centre of Medium Range Weather Forecasts	ECMWF	UK	month 1	month 54
7	Delft University of Technology	TUD	NL	month 1	month 54
8	Météo-France - Centre National de Recherches Météorologiques	MF-CNRM	FR	month 1	month 54
9	University of Stockholm	SU	SE	month 1	month 54
10	Eidgenössische Technische Hochschule Zürich	ETHZ	CH	month 1	month 54
11	University of Warsaw	UW	PL	month 1	month 54
13	German High Performance Computing Centre for Climate- and Earth System Research	DKRZ	DE	month 1	month 54

Part B

B.1 Concept and objectives, progress beyond state-of-the-art, S/T methodology and work plan

B.1.1 Concepts and Objectives

B.1.1.1 Background and Main Objectives

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) reaffirms that cloud-climate feedbacks remain one of the largest sources of uncertainty in global climate model projections for the 21st century response to anthropogenic radiative forcings. Climate (or Earth) System Models (ESMs) still predict a wide range of cloud radiative feedbacks (Soden and Held 2006, Webb et al. 2006, Ringer et al. 2006). Differences in the strength and even sign of these feedbacks are the dominant (by a factor of three or more) contributor to the uncertainty in model based estimates of climate sensitivity, both for equilibrium and transient climate changes (Dufresne and Bony 2008).

The difficulty that ESMs have in predicting clouds is not new, but stems from fundamental limitations in our ability to model the general circulation of the atmosphere. This limitation (or challenge) was recognized at the dawn of the climate modeling enterprise. In his assessment for the WMO Arakawa (1975) presciently notes that "*the modelling of time dependent cloud is perhaps the weakest aspect of the existing general circulation models and may be the most difficult task in constructing any reliable climate model".* A point later echoed by Charney's (1979) influential National Research Council report which states: *"It must thus be emphasized that the modeling of clouds is one of the weakest links in the general circulation modeling efforts"*. These findings have been reaffirmed by the latest 2 IPCC reports: "*Probably the greatest uncertainty in future projections of climate arises from clouds and their interaction with radiation...even the sign of this feedback remains unknown"* (IPCC TAR 2001) and to quote the AR4 "*Cloud effects remain the largest source of uncertainty in model based estimates of climate sensitivity.*" (IPCC AR4 SPM 2007).

As atmospheric general circulation models have evolved into coupled atmosphere-ocean-seaice-land models, the central role of clouds and cloud-related processes has not diminished. Quite the contrary, limitations in the representations of clouds have been shown to be central to many aspects of the coupled circulation, including coupled phenomena like ENSO (El Niño-Southern Oscillation) and the position of the Inter-Tropical Convergence Zone (ITCZ) (Philander 1983), or feedbacks such as soil-moisture - precipitation feedbacks so critical to regional climate (Hohenegger et al. 2008). Soil-moisture feedbacks also play a role in many more subtle interactions such as the nature of biosphere-atmosphere interactions that may be central to carbon cycle feedbacks as represented by ESMs. Such linkages are especially true in the tropics (Meehl et al. 2007), where circulations are more closely tied to diabatic processes. But also at the poles where recent work has suggested that cloud feedbacks may be critical in mediating cryospheric feedbacks, including rapid reductions in sea-ice. Clouds and precipitation are also known to be a primary agent through which the atmosphere rids itself of particulate matter, hence the distribution of the atmospheric aerosol depends sensitively on the representation of cloud processes (notwithstanding that attention is often directed the other way around; see Levin and Cotton 2008, for a full review). So as our conception of the Earth System has developed in sophistication, and our ability to enumerate climate feedbacks has grown, we find ourselves rediscovering in untold ways the prescience of Arakawa's remark.

So it is perhaps not surprising that an improved representation of clouds and related processes in Earth System Models is increasingly recognized (cf the experimental design for CMIP-5) as central to the climate prediction problem at large. Rather than damping the nature of cloud-climate interactions, the addition of process complexity in Earth System Models has multiplied pathways for the uncertainty in the representation of clouds to manifest itself on model-based estimates of climate change. **Consequently a (if not the) central challenge of climate science is to determine the sign and magnitude of cloud-climate feedbacks**.

EUCLIPSE represents a focused and integrated European effort to respond to this challenge by fostering coordinated research in the area of cloud feedbacks on climate change. The specific objectives of **EUCLIPSE** are thus to:

- ***Evaluate*** *the cloud-related processes in Earth System Models (ESMs) through integration of the latest observational datasets, cloud resolving simulations and new* ***process-oriented diagnostic techniques****;*
- *Develop our* ***physical understanding*** *of how cloud-related processes respond and feedback to climate change;*
- *Develop* ***strategies for testing*** *our physical understanding and for identifying and monitoring critical cloud-related climate indicators;*
- *Develop* ***metrics*** *to measure the relative credibility of the cloud feedbacks produced by different ESMs, thereby* ***demonstrating a reduction of the uncertainty*** *in model-based estimates of climate change.*
- *Improve the parameterization of cloud-related processes in the current ESMs*

These objectives directly address the aims of the EU Call ENV.2009.1.1.4.1 for the most uncertain among the most important climate feedback processes in our modelling of the Earth System.

To accomplish its objectives **EUCLIPSE brings together:**

- vigorous participation from the leading climate modelling centres within Europe;
- expertise in the analysis of space-borne passive and active remote sensing;
- cloud modellers with expertise in both cloud-resolving simulations and field data;
- leading experts in NWP (Numerical Weather Prediction) who have been developing new diagnostic techniques for evaluating the representation of parameterized processes within NWP and climate models;
- diagnosticians skilled in the design and analysis of ESMs and ESM experimental configurations.

Through the course of its activities**, EUCLIPSE will provide *direct* support** for**:**

- the European contribution to the planning and analysis of the Fifth Assessment Report of the IPCC;
- the maintenance, and improvement, of the world-class EU capacity in climate modelling and analysis (including the data infrastructure for this) and cloud research.

By addressing these issues in the context of other European and International initiatives, EUCLIPSE will help scientists, policy makers, and other users of ESMs to better understand key modelling uncertainties and the implications of these for their own work.

B.1.1.2 Overall Concept of EUCLIPSE

In addition to the (ill-founded) hope that additional process complexity would moderate the influence of uncertainties in cloud feedbacks, another reason for slow progress in the development of diagnostics and metrics for the evaluation of cloud-climate feedbacks has been the lack of observations. Until relatively recently reliable large-scale observations of many basic aspects of the three-dimensional distribution of clouds simply did not exist. Hence the parameterizations developed to represent clouds, including turbulent processes, moist convection, cloud microphysics and radiation tend to be poorly constrained by observations. Moreover, pseudo-empirical techniques, based on the simulation of clouds using high-resolution models incorporating sophisticated representations of cloud processes, tended to be developed by communities (such as the GEWEX Cloud System Studies, GCSS, working groups) in relative isolation of the climate modelling centres. So while groups such as GCSS were effective in using high-resolution simulations to improve the representation of cloud processes at a few modelling centres who could afford to be actively engaged within GCSS, their findings have only slowly percolated to the broader ESM community.

But this has begun to change. New data sets are emerging that are capable of, for the first time, probing the three dimensional spatial structure of clouds and cloud-related processes at a large scale. New partnerships between the community of scientists concerned with cloud and climate feedbacks, (such as the Cloud Feedback Model Inter-comparison Project CFMIP, http://www.cfmip.net), and those investigating cloud-scale processes (e.g. GCSS) are developing. New techniques, both in experimental design and in the analysis of climate model data, are lending new insights; and finally, the experimental design of the coupled model inter-comparison project (CMIP-5) which will provide the objective basis for much of the Fifth Assessment Report (AR5) of the IPCC, is attempting to provide a basis for communities, such as EUCLIPSE, to develop diagnostics and metrics for the evaluation and the understanding of cloud-climate feedbacks.

These changes are the principle motivation for EUCLIPSE and support our belief that a concerted, integrated, and sustained effort can make significant progress in the development of diagnostics and metrics for the evaluation of cloud-climate feedbacks. Categorically these changes or developments form our basic toolkit, and can be detailed as follows:

Observational Hierarchies: EUCLIPSE will focus on exploiting entirely new observations of clouds (primarily from active space-borne remote sensing such as are available from the CloudSat radar, the CALIPSO lidar, and the TRMM radar) in light of existing climatologies (such as the Earth Radiation Budget Experiment, ERBE, CERES, and the International Cloud Climatology Project, ISCCP). These new data allow, for the first time, the simultaneous evaluation of the *vertical distribution* of both the radiative and precipitation characteristics of clouds. To facilitate the use of these data EUCLIPSE will support the development and use of satellite simulators at international centres (e.g., the work of Joao Teixeira within WP3 is being supported by CALTECH). Such efforts will be complemented through the use of advanced, ground-based remote sensing at both the US Department of Energy ARM (Atmospheric Radiation Measurement) sites, as well as the climate nodes (Cloud-Net sites within Europe), the latter developed in part with the support of past EU funding. Field data will concentrate on maritime boundary-layer cloud regimes whose study has been motivated in part by the activities of GCSS. These include the DYCOMS-II (stratocumulus), RICO (trade-wind cumulus) and transitions from stratocumulus to cumulus (ASTEX) field studies, as well as other data of opportunity (e.g., the recent VOCALS stratocumulus study, or the ACE-II stratocumulus measurements). Furthermore, field data from deep convective clouds such as observed during the African Monsoon Multi-disciplinary analyses (AMMA) will also used for model evaluation. The use of satellite simulators in ESMs (developed by CFMIP and used in CMIP5) will be central to the development of consistent comparisons between models and observations.

Earth System Model Experiments: EUCLIPSE will exploit the richness of the CMIP-5 protocol, which has largely incorporated the proposed experiments of CFMIP to diagnose the basis for divergent cloud responses in ESMs. The CMIP-5 protocol includes a hierarchy of ESM experiments ranging from fully coupled ocean-atmosphere ESM simulations to atmosphere-only experiments with prescribed Sea Surface Temperatures (SSTs) for both present and future climate. Through EUCLIPSE, five leading European modelling centres (see Table 1.1.1) are committing to perform these experiments in their entirety, as well as additional simulations including: climate runs nudged to reanalyses, the analysis of initial tendency errors of climate models run starting from their own analysis, and the assessment of climate models in forecast mode. Doing so allows us to evaluate ESMs over a large range of spatial and temporal scales, as demanded by the “seamless” range of physical processes that characterize the climate system.

Simulations at Cloud Resolving Scales: EUCLIPSE will develop and target cloud-resolving simulation studies to specific questions identified in the analysis of ESM experiments. Such simulations will build on developing collaborations between CFMIP and GCSS. The latter has a rich experience in the use of cloud resolving models and targeted observations to critically test and improve cloud-related (e.g., convection, turbulence, entrainment, microphysics, radiation, precipitation) processes in large-scale models. Through EUCLIPSE these efforts will be extended to questions that relate specifically to cloud-climate feedbacks; thereby helping to constrain the behaviour of large-scale models at the process level.

Responsible Institute	ESM	CRM
MPG/ETH	(M1) ECHAM-5	UCLA-LES
ECMWF/KNMI	(M2) EC-EARTH	
CNRS-IPSL	(M3) IPSL-ESM	
METO	(M4) HadGEM2-ESM	UKMO-LES
MF-CNRM	(M5) Arpege	
TUD		DALES
WU		EULAG

Table 1.1.1 Earth System Models (and by implication major modelling centres) involved in EUCLIPSE. Note that each of the ESMs has an associated single-column model (SCM) representation and can realise the aqua-planet simulations. Cloud-Resolving Models (CRMs) and the responsible institutes within EUCLIPSE are also identified.

Novel Experimental Design and Analysis Techniques: EUCLIPSE will exploit the decision of WGCM (Working Group on Coupled Modeling) to incorporate idealised (aqua-planet) simulations within the CMIP-5 experimental design. These experiments will be extended (as necessary) within EUCLIPSE to help to isolate and diagnose the effects of key cloud-climate feedback processes. For instance, simplified aqua-planet ESM experiments highlight the interplay between deep and shallow maritime cumulus convection, as do simplified one-dimensional cloud feedback experiments with prescribed forcing derived from more complex experiments or data. In so doing they help to bridge what Held (2005) calls the widening "gap between simulation and understanding in climate modelling". Additionally, new regime-based methods of ESM analysis will be used to isolate the structure and variability of clouds in terms of physically meaningful regimes. These methods include compositing (e.g., Bony et al. 1997), and clustering (e.g., Tselioudis and Jakob 2002, Williams et al. 2006), where multiple cloud properties are used to define cloud structures corresponding to particular regimes (Williams and Tselioudis 2007, Williams and Webb 2008). These methods which have already proven capable of identifying cloud deficiencies in model simulations and have been used to connect those deficiencies with particular dynamic or thermodynamic processes will be augmented through the coordinated use of satellite simulators within EUCLIPSE.

Methodologically, EUCLIPSE will achieve its objectives by developing interdisciplinary teams spanning diverse research communities with expertise on different aspects of the cloud-climate problem, i.e., different components of the toolkit discussed above. This overall concept is illustrated in Fig. 1. The teams, defined in terms of work packages, are itemized in Table 1.1.2

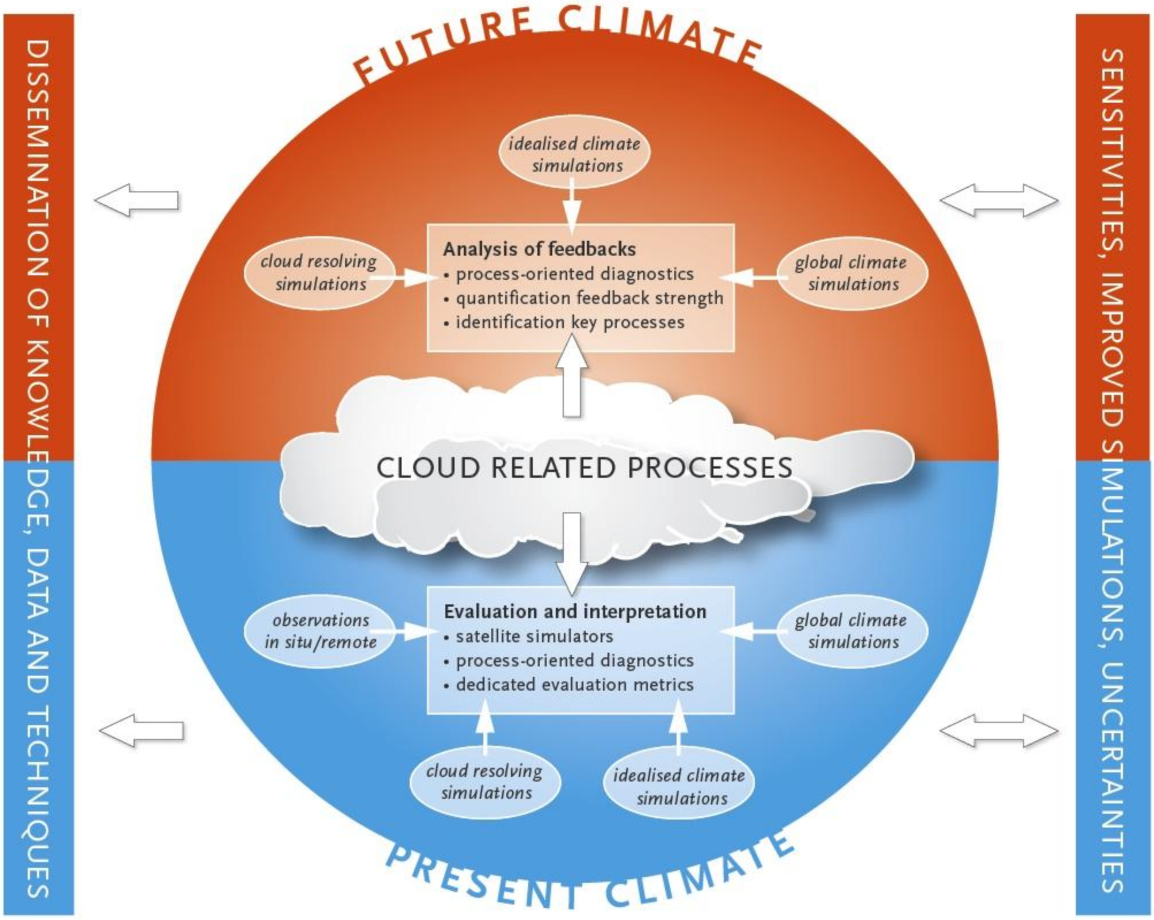


Figure 1: Overall Concept of EUCLIPSE.

WP1	Evaluation Techniques and Climate Model Experiments
WP2	Climate Model Evaluation and Analysis
WP3	Process-Level Evaluation
WP4	Sensitivity Experiments and Hypothesis Testing

Table 1.1.2 Work Package Structure of EUCLIPSE

These teams, indeed EUCLIPSE itself, are ***an organic outgrowth*** of the developing coordination and cooperation between the WGCM Cloud Feedback Model Intercomparison Project (**CFMIP**), a largely unfunded effort focused on the evaluation of ESMs in relation to cloud-climate feedbacks, and the GEWEX

Cloud Systems Studies (**GCSS**), also an unfunded international effort focused more on present-day process studies of cloud-related processes and the improved description of these processes in ESMs. These groups recently joined their forces and expertise, as evident by a joint CFMIP-GCSS meeting held in Paris in April 2007, a joint meeting in Toulouse in June 2008 and a recent meeting in Vancouver in June 2009. These joint efforts were instrumental in the development of the CFMIP-2 working plan. From these efforts emerged an experimental plan and sets of required climate model output which recently won approval by the Working Group on Coupled Modeling (WGCM) (see Bony et al., 2008[1]). These experiments focus a significant portion of the CMIP-5 experiments on cloud feedbacks (e.g., Taylor et al. 2008). They also motivate this proposal, as we envision EUCLIPSE as a mechanism through which we can extend and coordinate our analysis of the CMIP-5 experiments to learn as much as possible from these efforts, thereby better evaluating, understanding and narrowing uncertainty in cloud-climate feedbacks in advance of the fifth Assessment Report of the IPCC.

B.1.2 Progress beyond the state-of-the-art

The mean characteristics, the variability, and the sensitivity of the Earth's climate all arise from the interaction of physical and dynamical processes over a wide range of spatial and temporal scales. As discussed above, among these myriad interactions those involving clouds are considered especially important. Therefore, understanding how the climate system works and improving the simulation of the different characteristics of the observed climate by ESMs requires us to understand and to evaluate in models how the small-scale and short-term physical processes shape the simulated climate.

The paramount goal of EUCLIPSE will be to determine *how errors or shortcomings in the representation of cloud-related processes in ESMs affect the simulation of the large-scale climate through radiative, convective or dynamical feedbacks, both for the present and the future climates.* For this purpose, EUCLIPSE will evaluate the representation of cloud-climate feedback processes in ESMs using a diversity of observations (satellite, *in-situ*) and models (GCMs, SCMs, CRMs and LES), covering a wide range of spatio-temporal scales. Our methods will incorporate novel process-oriented methodologies of model-data comparison using both top-down and bottom-up approaches.

The progress beyond the state-of-the-art that EUCLIPSE will bring about is best described following the work-package structure of the project.

WP1 will provide new evaluation tools and climate simulation data for the cloud feedback analyses:

1.1 New algorithms, referred to as satellite simulators, will be developed that produce cloud data from model simulation output that can be compared unambiguously to various satellite-derived cloud data.
1.2 New diagnostic evaluation techniques incorporating process-oriented evaluation of the cloud-climate feedbacks in global simulations will be developed.
1.3 New ESM simulations specially designed to evaluate the cloud-climate feedbacks are planned with the participating ESMs in EUCLIPSE. These simulations will incorporate the newly developed simulators.

WP2 will provide novel analysis and evaluation of ESMs simulations of the large-scale climate at intra-seasonal, inter-annual and centennial time scales, and will relate errors (for the current climate) and uncertainties (for the future climate) to the simulation of specific cloud or moist processes. The approach of WP2 can be thought of as top-down, in which context three specific goals are identified:

2.1 New evaluations of cloud patterns and statistics as simulated by ESMs with particular reference to new and emerging satellite climatologies, and synthesize them through metrics.
2.2 Relate the ability of ESMs to simulate several key characteristics of the current climate to the simulation of specific processes such as clouds-radiation or convection-humidity feedbacks.

[1] http://www.clivar.org/organization/wgcm/wgcm-12/reports/CFMIP2_WGCM_Sept2008_FullProposal.pdf.

2.3 Quantify and understand, in advance of the AR5, the spread and character (for instance attribution to specific cloud regimes) of cloud and precipitation responses in simulations of climate change.

WP3 will develop process-level evaluations of, and constraints to, the representation of cloud-related processes in ESMs. The approach of WP3 can be thought of as bottom-up and as such will complement the top (Earth-System) down approach of WP2. Its efforts will also be centred around three specific objectives:

3.1 Evaluation of the process fidelity of cloud parameterizations within ESMs, with particular reference to boundary layer cloud regimes (whose representation has been identified as critical) and results from fine-scale modelling such as provided by Large Eddy Simulations.
3.2 Evaluation of the representation of clouds in ESMs at a number of selected points both in free climate simulations and in a numerical weather prediction (NWP) mode to assess the impact of errors in the representation of cloud processes on the simulated climate.
3.3 Development of new frameworks by which specific cloud-climate feedbacks can be evaluated using observations and idealised experimental configurations amenable to a hierarchy of models, including ESMs, SCMs and LES.

As EUCLIPSE proceeds, the complementary benefits of the bottom-up and top-bottom approaches will be assessed and used in a transverse approach, in WP4. Specifically, WP4 will develop and test hypotheses proposed to explain the inter-model spread in cloud feedback and climate sensitivity in ESMs. Within this approach EUCLIPSE will design and evaluate new experiments by at least a subset of the EUCLIPSE ESMs. These experiments will be designed to:

4.1 Evaluate (within specific ESMs) the origin of unusual behaviour, or specific sensitivities, identified within WP2.
4.2 Develop and test model improvements suggested by WP3 to improve the behaviour of the participating ESMs and narrow inter-model spread in cloud feedbacks.
4.3 Establish observational metrics, both direct and inferential, that can test our developing ideas, both directly and in the sense of future monitoring.

As discussed below, EUCLIPSE will develop these different actions by using new and state-of the-art observations, models and methodologies, in a way that will allow us to make substantial progress in the evaluation of ESMs, in our understanding of cloud-climate feedbacks, and in our ability to identify areas where specific parameterization improvements would enhance the predictive skill of ESMs and would reduce uncertainties in climate change projections.

B.1.3 S/T methodology and associated work plan

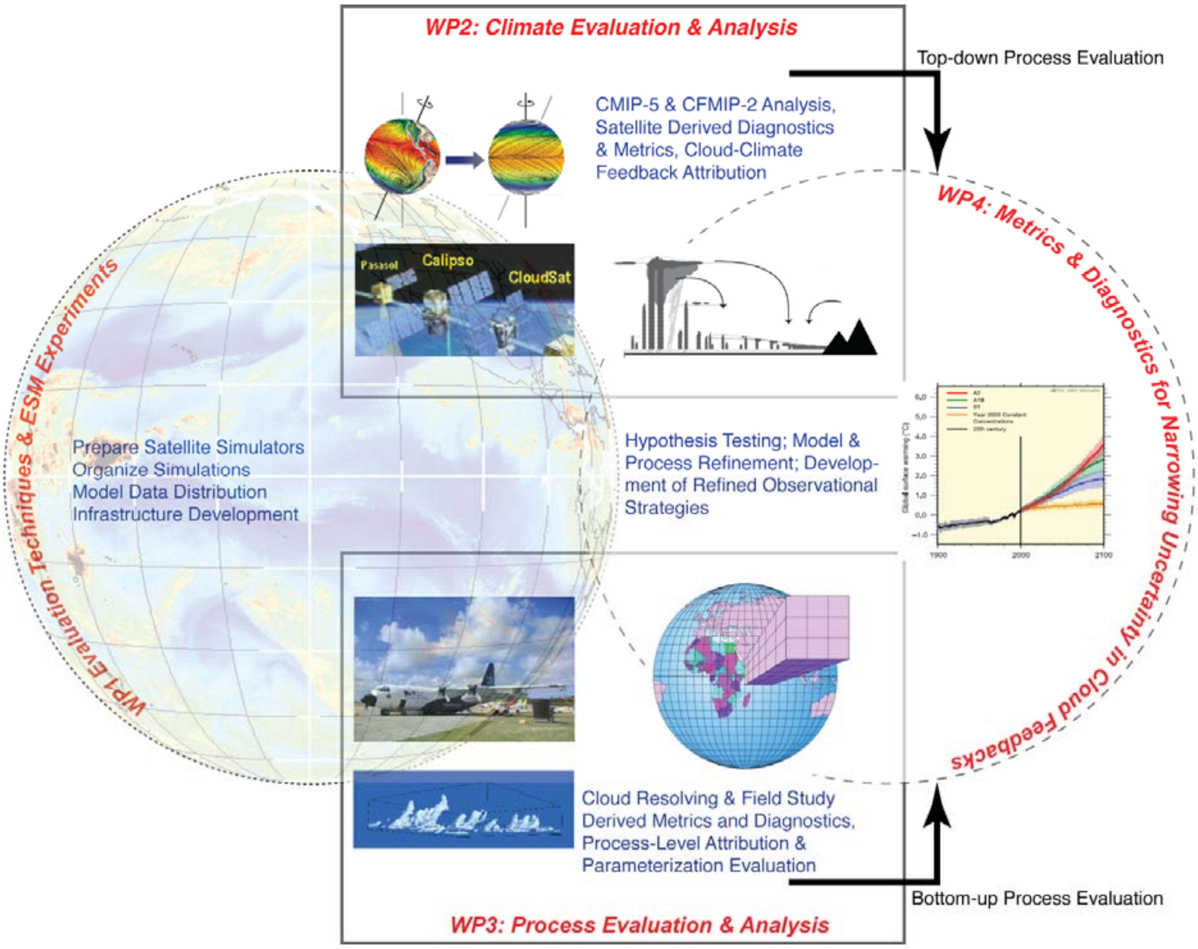


Figure 1.3 Schematic overview of the activities in the Work Packages and their linkages.

EUCLIPSE will stagger its work-packages to achieve the progress beyond the state-of-the-art as in the twelve objectives itemized above. These objectives are also linked to the WPs schematically in Fig. 1.3. During the first phase of the project (months 1-36) WP1 will prepare the model evaluation packages, implement the model diagnostics, execute the specified ESM model runs and organise the archiving and distribution of data. WP2 will focus on the top-down evaluation in months 13 to 54, as its work relies on many of the simulations being organised by WP1. WP3 will evaluate cloud processes on the process scale. Because much of WP3s work does not depend immediately on the ESM simulations it can begin activities already during month 1 and will carry on through month 36. WP4 will begin in month 13 as it depends on the evolving work of the other work-packages, and its synthesis activities will continue through the duration of the project. Almost every institution is involved in more than one work-package, and most institutions will contribute to all of the work-packages, which emphasises the integrative character of EUCLIPSE. The workflow is depicted in Figure 1.3 and in the Pert diagram (Section 1.3 iv). The methodologies of the four scientific work packages are further detailed below.

B.1.3.a Evaluation techniques and climate model experiments (WP1)

There are three main objectives that are addressed in WP1. The first is to prepare and implement to EUCLIPSE ESMs satellite simulator software, the second, to make available to the ESM groups the model evaluation packages that will facilitate the process-based evaluation of the model output, and the third, to execute the global model runs implementing the diagnostics that are necessary to better perform the process-based model evaluation studies.

B.1.3.a.1 Development and Implementation of the Satellite Simulator Software

The task of evaluating model output in a process-oriented manner is a complicated one, particularly when it involves satellite retrievals as the primary evaluation dataset. Where clouds are concerned, there is no unique definition of clouds or cloud types neither in models nor in observations. Therefore, to compare models with observations, and even to compare models with each other, it is necessary to use a *consistent* definition of clouds. By using model outputs to define quantities that are actually observed (rather than inferred) from satellites (e.g. visible/infrared radiances, radar reflectivities or lidar backscattered signals), software packages known as “simulators” allow models and observations to speak the same language and be compared quantitatively. The ISCCP simulator, which is now routinely used by many modelling groups, has been very valuable to compare models with each other and with observations from passive remote sensing instruments, to point out systematic biases of climate models and to analyse cloud feedbacks (e.g. Webb et al. 2001, Zhang et al. 2005, Webb et al. 2006, Williams and Tselioudis 2007, Williams and Webb 2008). Preliminary comparisons between GCM outputs and CALIPSO lidar observations (Chepfer et al. 2008) or CloudSat radar reflectivities (Haynes et al. 2007, Bodas-Salcedo et al. 2008) have shown the great potential of these new measurements for revealing systematic biases in the simulated clouds. To take advantage of these new measurements, new simulators are required. For this purpose, CFMIP has been developing the CFMIP Observational Simulator Package (COSP), a package that currently consists of three simulators (ISCCP, CloudSat and CALIPSO-PARASOL).

The research team developing COSP is participating in this proposal. In the context of EUCLIPSE, upgrades/improvements and optimisation will be made to the first production version of COSP, scheduled for release in 2009, in order to ensure easy application to the participating EUCLIPSE ESMs. COSP has been designed so that it can be run off-line or in-line. The off-line mode is only suitable for short experiments, as it requires a large volume of input data. Its in-line implementation is recommended for longer experiments. The final version of the COSP simulator will be applied in-line to the EUCLIPSE suite of ESMs, with the option to perform off-line implementation or optimisation of the simulator by individual modelling groups. Particular attention will be paid to the optimisation of the CloudSat simulator, so that it may be used not only off-line but also in-line together with the other simulators.

EUCLIPSE participants will also produce and distribute to the modelling community “GCM-oriented products” from CALIPSO and PARASOL satellite observations, that will be fully consistent with the diagnostics derived from the CALIPSO and PARASOL simulators of COSP (Chepfer et al. 2008, http://climserv.ipsl.polytechnique.fr/cfmip-atrain.html): e.g., three-dimensional cloud fraction on 40 vertical levels from CALIPSO, mono-directional reflectances associated with several solar zenith angles from PARASOL.

B.1.3.a.2 Development of Diagnostic Techniques

In addition to the use of simulators to create model outputs comparable to the observational retrievals, the process-based evaluation of models requires the application of methodologies that divide model and observational outputs into regimes that have physical meaning. This way, model deficiencies in a particular regime can be better attributed to the physical processes that are dominant in that regime. Several methods have been used lately to examine cloud and precipitation variability in the context of such regimes. The methods include compositing, where one or more atmospheric properties are used to define regimes and composite cloud and precipitation properties in them (Bony et al. 1997) , and clustering (Tselioudis and Jakob 2001, Williams et al. 2006), where multiple cloud properties are used to define cloud structures corresponding to particular regimes (Williams and Tselioudis 2007, Williams and Webb 2008). These methods have proven capable of identifying cloud deficiencies in model simulations and have been used to connect those deficiencies with particular dynamic or thermodynamic processes.

Since several of the compositing and clustering techniques have been developed by participants in EUCLIPSE, changes and improvements will be applied to those techniques within the context of this proposal with two primary objectives. The first is to improve the degree to which the techniques resolve the cloud formation and water cycling processes and the second is to examine ways to apply combinations of different techniques to ESM output. The resulting evaluation packages will be made available to WP2, WP3, and WP4 for model output analysis and evaluation work, and will be provided to the Infrastructure for the European Network for Earth System Modelling (IS-ENES) evaluation portal for dissemination to the Earth Science community.

B.1.3.a.3 Planning Organisation and Archival of ESM simulations

EUCLIPSE ESMs will perform a hierarchy of experiments, in particular those proposed by CFMIP-2 as part of the CMIP-5 coordinated experiments. Additional experiments will be designed specifically to isolate and understand the effects of climate warming and the resultant circulation changes on clouds and precipitation, and to investigate the processes responsible for the differences in model cloud feedbacks. The initial suite of EUCLIPSE climate experiments will be performed in the context of WP1. The basic characteristics of those experiments and the set of additional diagnostics that will be implemented to better investigate cloud feedback processes are detailed below.

a) Atmosphere-only experiments with 'realistic' control simulations

Gregory and Webb (2008) have shown that a significant fraction of inter-model spread in cloud 'feedback' in slab models occurs shortly after doubling the atmospheric CO2 concentration in the simulation. It is not in fact related to the global mean surface temperature response, but results from the rapid cloud response to changes in atmospheric structure that are induced by the CO2 increase. To allow these two aspects of cloud 'feedback' to be separately quantified, the following experiments will be run, using the 30-year (1979-2008) CMIP5 AMIP run as a control simulation (an Atmospheric Model Intercomparison Project, AMIP, run is an atmosphere-only experiment forced by observed SSTs):

1. A ‘Hansen-style’ experiment of 30 years where a 4xCO2 perturbation is imposed to an AMIP simulation; this experiment will allow us to diagnose the fast cloud adjustment to CO2 radiative forcing,

2. A patterned-SST experiment, where a change in SST pattern derived from a composite of the CMIP3 coupled model response at time of CO2 quadrupling is imposed on top of AMIP SSTs; this experiment will allow us to isolate the role of atmospheric processes in the response of clouds and precipitation to global warming in the different climate models.
3. A uniform (FANGIO-like) SST forced global warming experiment (+4K), to minimize atmospheric circulation changes and thus isolate the effect of temperature changes on clouds and precipitation.

Although these experiments are not expected to reproduce exactly the global mean cloud feedbacks as in a coupled experiment or slab experiments, they are expected to explore the same range of cloud feedback processes and to allow the effects of local and remote changes in SST on cloud feedbacks to be assessed (Wyant et al 2006, Ringer et al 2006, Caldwell and Bretherton, 2008).

b) Idealised Aqua-planet experiments

Aqua-planets are examples of simplified models. By using the idealised boundary conditions proposed by the Working Group on Numerical Experimentation (WGNE) Aqua-Planet Experiment Project (APE, Neale and Hoskins 2001) and by adding perturbations to the SST or of the CO2 concentration, one may investigate the cloud response to global warming in a simplified, idealised framework where complexities associated with land-surface processes, monsoons, or the Walker atmospheric circulation, do not come into play. The value of such experiments in isolating the cloud-feedbacks of several GCMs was recently established by Medeiros et al. (2008).

The protocol to be followed will be largely similar to that proposed by APE and adopted by CMIP-5 and CFMIP: A “control climate” simulation using a zonal distribution of SST derived from observations and no sea-ice at high latitudes, and perturbation experiments adding a uniform +4K perturbation and quadrupling atmospheric CO2 concentration.

c) Additional Model Diagnostics

Additional diagnostics will be implemented within EUCLIPSE ESM model runs. The selection of those ESM outputs is guided by the wish that:

1. The number of GCM outputs be as high as possible, maximising the opportunities for process-based model evaluation in the context of WP2.

2. The selection of diagnostics be justified by published studies demonstrating the effective usefulness of the requested outputs.

3. Diagnostics are made available that reflect the tremendous advancement (and enormous investment) in satellite remote sensing available to the current epoch of climate simulation.

One primary set of such diagnostics is the output from the COSP simulator. The set of simulator output variables planned for long-term integrations includes:

- Cloud top pressure - cloud optical thickness joint histogram diagnostics from the ISCCP simulator
- Gridbox mean cloud cover, cloud albedo and cloud top pressure from the ISCCP simulator
- Low-level, mid-level, high-level and total cloud cover from the CALIPSO simulator
- Vertical profile of cloud fraction from the CALIPSO simulator
- Mono-directional PARASOL-like reflectances for different solar angles

The set of simulator output variables planned for short periods (1-3 years) includes the lightweight set of simulator diagnostics defined above but in addition requires joint height-reflectivity distribution of CloudSat radar outputs, joint height-lidar scattering ratio distribution of lidar outputs, as well as cloud frequency of occurrence as seen by CALIPSO but not CloudSat, required for studies making combined use of CloudSat/CALIPSO simulator output.

For a 1-year period of the AMIP control experiment, 3-hourly global instantaneous outputs are planned. These experiments will allow the process modelling groups in WP3 to examine the representation of cloud processes by GCMs in the current climate in any climate regime or meteorological situations without imposing *a priori* geographical constraints.

For several years of the AMIP control run, 3-hourly outputs are planned along a few transects (e.g. GCSS/WGNE-Pacific Cross-section Intercomparison - GPCI, VOCALS) or locations for which a large number of observations will be available (satellite data for GPCI, field campaign for VOCALS, long-time series of ground-based observations for ARM or CloudNet instrumented sites). As shown by Siebesma et al. (2004) and Mapes et al. (2008), these outputs will also inform the design of idealised SCM/CRM/LES case studies of WP3.

A number of additional diagnostics are planned that are specifically designed to explore cloud and precipitation microphysical processes. The lightweight nature of the EUCLIPSE experiments (max 20 years in length) means that data volumes are small, allowing a more extensive diagnostic list. Those additional diagnostics include cloud condensate tendency diagnostics (CCTD) that will be used to gain insight into the physical mechanisms responsible for cloud feedbacks (Ogura et al., 2008a, 2008b), temperature and humidity tendency terms (including 3D radiative fluxes) to assess (for example) the impact of changes in convection and boundary layer mixing on the atmospheric structure, hydrological cycle, and clouds in the warmer climate (Zhang and Bretherton 2008), and 3-hourly global instantaneous 'snapshots' of 3D mixing ratios and size parameters (clouds and precipitation) to support the development of future COSP modules (e.g. Combined CloudSat/CALIPSO, TRMM, MLS, RTTOVS)

EUCLIPSE model output will be inserted in the WDCC database system and will augment the planned CMIP-5 data base. The additional EUCLIPSE data ingestion will reuse the CMIP-5 technical data interfaces. Data and metadata ingestion will be along the CMIP-5 guidelines and therefore can be easily performed by each modelling project partner. EUCLIPSE data management will focus on data curation and dissemination.

B.1.3.b Climate model Evaluation and Analysis (WP2)

In WP2, we will analyse the CMIP5 climate simulations executed in WP1, in support of the 5th Assessment Report of the IPCC, by climate and weather prediction GCMs. The aim of our analysis will be two-fold:

- To evaluate the ability of GCMs to reproduce the observed climate, with a particular focus on clouds, precipitation and radiation, and to relate errors associated with the simulation of some critical climate phenomena, *e.g.* the structure of the ITCZ, tropical climate variability at intra-seasonal and inter-annual timescales, temperature extremes over Europe, to the simulation of specific cloud or moist processes.

- To analyse the climate change simulations performed by the same models to assess the uncertainty in projections of future cloud and precipitation changes, and to understand the physical processes underlying this uncertainty.

For this purpose, WP2 will use the tools and the methodologies developed in WP1 and in interaction with WP3 and WP4, will contribute to develop and propose modelling and observational strategies to improve the predictive skill of climate and weather prediction models.

B.1.3.b.1 Evaluation of clouds using COSP and the new generation of satellite observations.

By using both the original methodologies of model-data comparison developed in WP1 (e.g., clustering and compositing techniques) and satellite observations from both passive (ISCCP, MODIS, AVHRR, PARASOL) and active (CloudSat, CALIPSO) instruments, it will be possible to evaluate for the first time, from the tropics to the Arctic, the three-dimensional cloud fraction, the distribution of hydrometeors (cloud water content and precipitation), the cloud optical thickness and other microphysical (e.g. aerosol concentrations and properties) and radiative properties simulated by GCMs. We will quantify the extent to which the accurate simulation of top-of-atmosphere radiative fluxes in current ESMs is due to compensating errors, and will be able to develop more discriminating cloud metrics suitable for the evaluation of clouds, precipitation and radiation by any climate or weather prediction model. This will address a major recommendation from the WGNE, GEWEX and WGCM panels.

Methodology and associated work plan

The first task of WP2 will consist in using the tools (e.g. COSP) and the methodologies developed in WP1 (process-oriented diagnostics, original methods of model-data comparison) together with satellite observations from passive and active instruments to:
1. Evaluate the three-dimensional large-scale fields of clouds, precipitation and radiation simulated by the different models (Task 2.1.1), to point out systematic errors associated with particular cloud regimes or environmental conditions using compositing and clustering techniques (Task 2.1.2) and then to unravel compensating errors in the simulation of the Earth's radiation balance and cloud radiative forcing (Tasks 2.1.1 and 2.1.2). A particular focus will be put on:

(i) Regions associated with marine boundary-layer clouds, because of their critical role in climate change cloud feedback uncertainties (e.g. Bony and Dufresne 2005)
(ii) Clouds simulated over western tropical Africa during the summer monsoon, because of the large uncertainty in the simulation by ESMs of monsoon regimes and associated clouds and precipitation in the current and future climates (IPCC 2007), especially along the AMMA-MIP transect (http://amma-mip.lmd.jussieu.fr)
(iii) Arctic clouds, because of the large magnitude of the projected climate warming there and the importance of cloud changes for the sea-ice response and surface albedo feedbacks (e.g. Vavrus 2004)
(iv) Clouds associated with mid-latitude storms, because of their large impact on the Earth's radiation budget, and their critical role in the simulation of the equator-to-pole energy transports, in the frequency and intensity of extreme events over Europe, and in climate change cloud radiative feedbacks,
(v) Clouds forming along the GPCI transect, to consider the transition between the different cloud types and to interact with the process studies carried out in WP3 along this transect.

2. Assess the simulation of "aerosol indirect effects" in ESMs (Task 2.1.3). Several recent studies have shown that satellite-derived relationships between aerosol concentration and cloud properties allow for a process-oriented evaluation of aerosol-cloud-radiation interactions (e.g., Lohmann and Lesins 2002, Quaas et al. 2006). The aerosol, cloud, and radiation quantities will be simulated by a MODIS-simulator in the GCMs. The statistical relationships between aerosol concentration, cloud properties, and top-of-the-atmosphere radiation will be analysed for individual regions consistently for satellite observations and the GCMs in order to assess the model parameterizations of the aerosol-cloud interactions. The study will include an assessment of the uncertainty of satellite-derived relationships.

3. Develop a set of climate and process-based metrics that will quantify and synthesise the ability of climate and weather prediction models to simulate clouds, precipitation and radiation in the current climate (Task 2.1.4). First, we will apply existing state-of-the art metrics (*e.g.* Pincus et al. 2008, Williams and Webb 2008) to CMIP5 climate model simulations. Then we will explore the development of new metrics, based on the diagnostics developed in Tasks 2.1.1 to 2.1.3, and on the diagnostics developed in Task 2.2.

B.1.3.b.2 Relating the ability of ESMs to simulate key characteristics of the current climate to their ability to simulate clouds-radiation and convection-humidity feedbacks.

ESMs exhibit systematic errors and persistent difficulties in the simulation of the current climate. In particular, many coupled ocean-atmosphere models simulate an unrealistic double-ITCZ pattern in the tropical pacific, exhibit a warm bias at the eastern side of the ocean basins and simulate a 'cold tongue' that extends too far to the central pacific (e.g. Zhang et al. 2005, Dai 2006, Gleckler et al. 2007), and simulate poorly the tropical intra-seasonal (Lin et al. 2006) and inter-annual variability, including the Madden-Julian Oscillations (MJO) or El Niño-Southern Oscillation (ENSO), respectively (Achutao and Sperber 2006, Guilyardi 2006), as well as climate extremes (Randall et al. 2007).

By examining the ability of the European models to simulate these different features in the suite of CMIP5 simulations (coupled ocean-atmosphere simulations, atmosphere-only simulations, aqua-planet simulations), we will examine the extent to which the representation of atmospheric processes is responsible for part of these errors. Past model inter-comparisons, along with our physical understanding of these phenomena, already suggest that the representation of cloud and moist processes is likely to play a significant role. For instance, several studies have pointed out the dominant role of the atmosphere component in setting ENSO characteristics of coupled ocean-atmosphere GCMs (Schneider 2002, Guilyardi et al. 2004, Neale et al. 2008, Sun et al. 2008, Guilyardi et al. 2009a,b) although the processes responsible for this dominant role remain unclear. Similarly, cloud-radiation feedbacks and moisture-convection feedbacks have shown to play an active role in the MJO and in the ability of GCMs to simulate this variability (e.g. Lee et al. 2001, Tompkins 2001, Grabowski and Moncrieff 2004, Bony and Emanuel 2005, Zurovac-Jevtic et al. 2006). By investigating the link between the ability of ESMs to predict MJO and ENSO variabilities and to simulate cloud and moist processes, EUCLIPSE will help to unravel some of the reasons why ESMs display such a wide range of skills in simulating tropical variability at intra-seasonal and inter-annual time scales, and thus will identify ways to correct biases in ESMs.

To understand the difficulty of ESMs in simulating tropical precipitation patterns, in particular the existence of an off-equatorial ITCZ and the occasional appearance of a double ITCZ in the Pacific ocean, EUCLIPSE will analyse the suite of CMIP5 simulations performed by European models, and particularly aqua-planet atmospheric simulations. Indeed, these simulations have proven useful to identify multiple equilibria or regimes of the Hadley circulation, with different signatures in terms of precipitation (Chao 2000, Chao and Chen 2001, 2004, Barsugli et al. 2005). The robust double-ITCZ bias of GCMs (Dai 2006) is related to the misrepresentation of these regimes and of the transitions between regimes during a seasonal cycle. This bias in turn affects phenomena at shorter and longer timescales such as the MJO and ENSO. EUCLIPSE will investigate the feedbacks that cause the stability of the different equilibria and the transition between regimes, in particular the role of the convection-humidity feedbacks and cloud-radiative feedbacks, and thus will develop new approaches to cure the *double-ITCZ syndrome.*

The occurrence of temperature extremes (heat waves and cold spells) over Europe is closely related to the variability of the large-scale atmospheric circulation. The different weather regimes that dominate the synoptic atmospheric variability affect the cloudiness in different ways, and the interaction of clouds with temperature and precipitation is likely to affect the intensity of the surface temperature response to these regimes. Moreover, through their radiative and latent heating effects, clouds strongly control the large-scale atmospheric circulation both at the planetary and regional scales, and thus the precipitation and the continental hydrology (e.g. soil moisture). By investigating the relationship between simulations of European temperature extremes and cloud/moist processes across ESMs, it will be possible to understand why the ability to predict the occurrence and the magnitude of temperature extremes varies among models, and to identify possible ways of improvement.

Methodology and associated work plan

The second task of WP2 will be to examine the influence of the representation of cloud and moist processes in the simulation of a few key prominent features of the current climate: the ITCZ and the MJO (Task 2.2.1), ENSO (Task 2.2.2), and temperature extremes over Europe (Task 2.2.3).

The ability of climate and weather prediction models to simulate the mean distribution of tropical precipitation, the MJO, and ENSO will first be assessed by using the set of diagnostics and metrics recently developed by the CLIVAR MJO and ENSO Working Groups (Waliser et al. 2008, Guilyardi et al. 2009a). The relationship between the ability of GCMs to simulate MJO and ENSO variabilities (as assessed by the CLIVAR metrics) and to simulate cloud, precipitation and radiation fields (as assessed by the metrics developed in Task 1.4 of this work package) will then be examined. Then process-oriented diagnostics will be developed to assess the role of convection-humidity feedbacks, cloud-radiation feedbacks, the transition between dry and precipitating regimes, in the simulation by GCMs of the ITCZ, MJO and ENSO. For this purpose, key relationships between SST, convection, clouds, humidity, precipitation and radiation will be derived from observations and from coupled ocean-atmosphere simulations, atmosphere-only simulations and aqua-planet experiments.

The ability of climate and weather prediction models to simulate temperature extremes over Europe will be assessed in CMIP5 simulations and in AMIP-type simulations nudged to ECMWF reanalyses (ERA-Interim will be used for the recent period). As a first step, the occurrence of temperature extremes (composites of daily maximum and minimum temperatures) will be analysed as a function of weather regimes (defined as clusters of the 500 hPa geopotential height), both in models and in observations. Then, daily diagnostics from COSP (in particular from the ISCCP simulator) will be used to stratify cloud properties according to these regimes. Then it will be possible to diagnose and to evaluate the high-frequency cloud variability, and to disentangle the role of large-scale dynamics versus regional processes in this variability. By comparing the role of cloud variability and other regional feedbacks such as the land surface hydrology, it will be possible to assess the influence of the representation of cloud processes on the simulation of temperature extremes in Europe.

The ability of GCMs to simulate these key features of the large-scale climate will finally be related to the process-level tests and evaluations carried out in WP3. It will allow us to propose some specific improvements of parameterizations that might improve the simulation of the ITCZ, of the MJO, of ENSO and of European temperature extremes by climate and weather prediction models.

B.1.3.b.3 Understanding the spread of cloud and precipitation responses to climate change.

Many factors and processes potentially contribute to the spread of cloud-climate feedbacks and precipitation responses. A prerequisite for the design of a scientific strategy that would allow us to reduce the uncertainty in cloud feedbacks is to better understand the reasons for this spread.

As reviewed by Bony et al. (2006), some progress has been made during the last few years on this issue. In particular, low-level clouds have been identified as the primary (direct) contributor to the spread of GCM cloud feedbacks in climate change (Bony and Dufresne 2005, Webb et al. 2006, Wyant et al. 2006). However, many questions remain unanswered, such as the type of low-level clouds that predominantly explains the spread of cloud feedbacks, or the local and/or remote mechanisms that control the low-clouds response (e.g. the extent to which the representation of deep convection and the remote response of clouds in the ascending branches of the large-scale circulation influences the behaviour of low-level clouds in the sinking branches of the circulation remains an open issue).

Some progress will be made on these issues by analysing the climate simulations through a variety of process-diagnostics and a range of numerical experiments. Based on past experience (Bony and Dufresne 2005, Webb et al. 2006, Williams and Tselioudis 2007, Williams and Webb 2008) and using the improved methodologies developed in WP1, we will decompose the global cloud feedbacks and the precipitation response in terms of cloud or dynamical regimes. In addition, as pioneered by Wyant et al. (2006), Medeiros et al. (2008) or Gregory and Webb (2008), we will analyse the suite of CFMIP2/CMIP5 experiments performed by each model, both in realistic and idealised or simplified configurations, to test the robustness of the simulated responses and to unravel the relative roles of CO2, surface temperature and large-scale atmospheric circulation changes on the response of clouds and precipitation simulated by each model. These analyses will thus help to understand the climate response to global warming in each climate model, and to interpret the diversity of simulated behaviours in terms of physical processes and model formulation.

Methodology and associated work plan

In the third task of WP2, we will quantify and interpret the diversity of cloud-radiative feedbacks and precipitation responses produced by climate models in climate change simulations.

In Task 2.3.1, we will use several methodologies, including the 'kernel' type of partial radiative perturbation method (Soden and Held 2006) and the change in TOA radiative fluxes (Webb et al. 2006) to diagnose in GCMs the different climate feedbacks associated with changes in clouds, water vapour, surface albedo, temperature lapse rate and carbon cycle. Then we will quantify the contribution of each feedback to the inter-model spread in climate sensitivity (Dufresne and Bony 2008) and in the response of the global hydrological cycle. Inter-model differences in the prediction of future cloud and precipitation responses to global warming will also be quantified at the regional scale. The spread in climate feedbacks among the new generation of climate models will be compared with that of the previous generation of models (CMIP3) to assess the evolution of the uncertainty in climate feedbacks and sensitivity.

In Task 2.3.2, we will identify the processes primary responsible for the spread of cloud and precipitation responses produced by GCMs in climate change. For this purpose, we will analyse the large-scale feedback mechanisms and cloud changes in terms of weather regimes, dynamical regimes and cloud types by using compositing and clustering methodologies similar to those used to evaluate the simulation of clouds in the current climate (Task 1.2). In CMIP3 models, the response of low-level clouds had been identified as the primary contributor to the spread of climate change cloud feedbacks. The analyses proposed here will allow to examine whether it is still the case in CMIP5 models, and will identify more precisely the cloud types (e.g. low-level stratus, stratocumulus or trade-cumulus clouds) and the physical processes associated with them.

In Task 2.3.3, we will refine the identification of the main source of spread of cloud and precipitation responses and will examine its dependence on the degree of complexity of climate models. By analysing the

CMIP5/CFMIP2 suite of experiments performed by GCMs in simplified or idealised (aqua-planet) configurations (cf WP1), we will isolate and understand the effects of warming and resultant circulation changes on clouds and precipitation and the timescale of cloud and precipitation responses (e.g. the fast cloud adjustment to CO2 radiative forcing versus the longer-term interaction of clouds with the surface temperature field). We will also better identify the cloud types and the climate regimes mostly responsible for the spread in cloud feedbacks and precipitation responses (e.g. stratus clouds are simulated in realistic climate configurations but not in aqua-planet configurations because of the lack of cold waters and upwelling; land-surface processes can contribute to the spread of precipitation responses in realistic configurations but not in aqua-planet configurations). These analyses will then help us to make a hierarchy among the different processes contributing to the uncertainty of future climate projections, thereby providing guidance regarding necessary model developments, and the establishment of a strategy to reduce uncertainties in key critical processes.

B.1.3.c Process-Level Evaluation (WP3)

WP3 aims to evaluate how the large-scale forcing conditions control cloud cover, cloud amount, precipitation, and how these cloud properties influence the radiative budget and to what extend this is faithfully reproduced by the ESMs. The focus will be on the subgrid processes that act on the grid scales of ESM (of the order of 100 km). To this purpose WP3 will use a bottom up approach. First, on the shortest time scales of days, WP3 will conduct dedicated high resolution simulations and analyses with Large Eddy Simulation (LES) models and use the results to evaluate Single Column Model (SCM) versions of ESMs. Secondly, on the time scale of months ESMs will be evaluated with respect to key cloud regimes on selected locations for present climate. Finally, to understand the cloud response in a perturbed future climate, SCMs and LES experiments will be done on the same locations, but now with correspondingly different time series of large scale dynamical forcings taken from the future climate runs of ESMs as conducted in WP1.

B.1.3.c.1 Evaluation of boundary-layer cloud processes with fine-scale models and observations

Fine-scale models such as used in Large-Eddy Simulation (LES) have, in conjuction with single column models (SCMs), been the work horse of GCSS's effort to evaluate and improve parameterization schemes used in ESMs (Siebesma and Holtslag 1996). Observations from field campaigns are used to initialise and constrain Large Eddy Simulations. By subsequently comparing the cloud and moist processes simulated by LES or CRM models with those simulated by SCMs, one may identify deficiencies in the ESMs parameterizations. Fine-scale models also provide a framework for interpreting field data for use in the evaluation of assumptions used in the development of ESM parameterizations. Together the framework has been shown by GCSS to advance the development of parameterizations.

This (the GCSS or the FP5 EUROCS) approach will focus on the marine boundary-layer cloud regimes thought to be responsible for much of the inter-model differences in climate change cloud feedbacks (Bony and Dufresne 2005, Webb et al. 2006, Williams and Webb 2008, Medeiros et al. 2008). Specific deficiencies in the ESM representation of cloud-related processes in these regimes will be evaluated and model remedies will be identified. Specific issues include questions related to the amount of turbulent mixing like the eddy-diffusivity profiles; the specification of turbulent length scales; the representation of cloud-top entrainment, as well as lateral entrainment and detrainment rates and the cloud-base mass flux in regions of shallow cumulus. Emphasis will be placed on simulations of regime transitions such as observed over the North Atlantic during ASTEX, but also as being studied in the context of the GEWEX Pacific Cross-section Intercomparision project (GPCI, Siebesma et al. 2004).

The 3D fields from fine-scale models will be archived to provide researchers the possibility to compute detailed radiative transfer calculations on the basis of 3D cloud fields, and to verify assumptions concerning joint probability densities of thermodynamic quantities in cloud layers. This Task 3.1 will be led by Stephan de Roode of the TU Delft.

B.1.3.c.2 Evaluation of ESMs in free climate and weather prediction modes at selected locations

In the previous task cloud processes were analysed on a ESM grid scale with LES models and SCMs in isolation on short time scales of the order of days with the best estimates of the large scale forcings. In this next task, the output of high frequency (3-hourly) data of the ESMs on longer time scales of the order of seasons will be analysed for a number of selected locations. To this purpose 2 strategies will be pursued:

a) ESM evaluation in a NWP mode

To what extent can uncertainty in cloud-climate feedbacks be constrained by the short-time behaviour of parameterised cloud processes? This question will be addressed in both WP3 and WP4, but here in the context of single-point analysis. The utility of using ESMs in an NWP mode (an approach sometimes referred to as "Transpose-AMIP") has been shown useful to identify sources of systematic biases in ESMs (e.g. Boyle et al. 2008, Gleckler et al. 2007, Williams and Brooks 2008).

ESMs participating in EUCLIPSE will run Transpose-AMIP simulations over periods for which field data are available (e.g. GPCI, AMMA, ARM or CloudNet). In practice, this implies that for a given period, ESMs will produce on a daily basis, 5 day forecasts from a prescribed analysis (ERA-Interim). This will facilitate the comparison between simulations and field data at specific locations, and will provide insights into model parameterization deficiencies at a timescale short enough that the impact of these deficiencies on the dynamics of the model remains limited (an assumption that is being tested in WP4) thus simplifying the analysis, and shortening the model development cycle.

b) ESM evaluation in a free climate mode

At the next level of complexity high-frequency diagnostics from present-day ESM simulations conducted in WP1 will be analysed for a number of selected grid points. This will introduce an extra level of complexity since the feedback of the physical processes will influence the large scale dynamics, contrary to the Transpose-AMIP experiments. The increase of errors in these experiments with respect to the Transpose-AMIP runs will help quantify how much cloud biases are due to the fast (parameterized) cloud related processes or versus errors in the large-scale state. These evaluations will close the loop with the ESM evaluations done on a global scale in WP2. Although the evaluations done in WP3 will only be performed on a selected number of locations, the main difference with the global evaluations in WP2 is that temporal high frequency model output will be evaluated. These high frequency diagnostics are expected to give more insight into the physical processes and the interactions between them (e.g. convective intermittency and convective/boundary layer interactions).

Such diagnostics will be analysed across three categories of grid points as outlined below:

i) A northeast **Pacific transect** that crosses three important cloud regimes: marine stratocumulus, shallow and deep cumulus. Previous intercomparisons of monthly mean properties between models and observations along the Pacific Cross Section in the European FP5 project EUROCS showed that most models suffer from negative stratocumulus cloud bias and positive shallow cumulus bias (Siebesma et al. 2004). However, due to the lack of suitable observational data and advanced evaluation techniques it was not possible to draw further conclusions on the origins of these biases. EUCLIPSE will rectify this situation. In collaboration with the GEWEX Pacific Cross Section Intercomparison Project (GPCI) we will evaluate the high resolution ESM model data with cloud observations derived from new satellite products for the June-July-August 2008 period. These observations include the Atmospheric Infrared Sounder (AIRS)-derived temperature and humidity profiles, cloud top heights derived from the Multi-angle Imaging SpectroRadiometer (MISR) and the CloudSat and CALIPSO data that will provide detailed information on the vertical structure of the cloud properties. The use of COSP will facilitate the objective intercomparison between the ESMs and satellite derived cloud products. This task 3.2.1 will be coordinated by Roel Neggers of The KNMI.

ii) **Advanced atmospheric profiling stations** such as the Southern Great Plains (SGP) site of the Atmospheric Radiation Measurement (ARM) Program (Stokes and Schwarz 1994), and European sites such as the KNMI Cabauw site (Van Ulden and Wieringa 1996) and the SIRTA site (Haeffelin et al. 2005). As far as the two latter European sites are concerned, EUCLIPSE will profit from the European FP5 project CloudNet (Illingworth et al. 2007), that has established an observational data service, which will facilitate the evaluation of the ESM simulations with observational data from these sites. An evaluation period of May-August 2008 is selected, mainly because this period coincides with an Intensive Observing Period (IOP) organised by the European FP6 project EUCAARI. This task 3.2.2 will be coordinated by Frank Selten of KNMI.

(iii) A **west-Africa** transect (http://amma-mip.lmd.jussieu.fr) coinciding with the IOP of the AMMA campaign (Redelsperger et al. 2006) during which a wealth of surface and atmospheric observations are available that allow critical evaluation of ESM simulation with the African Monsoon over this area. This task 3.2.3 will be coordinated by Françoise Guichard of MF-CNRM.

B.1.3.c.3 Response of boundary-layer clouds to future climate conditions

To better understand the processes underlying the response of boundary-layer clouds to global warming, an idealised set-up of climate change experiments that simplifies the large-scale dynamics and mimics the behaviour of the subsidence regimes of the subtropical eastern oceans will be used (Zhang and Bretherton 2008). Preliminary investigations show that when applied to SCMs and to different LES models, LES models exhibit more consistent responses than climate models, and that it appears possible to quantitatively reproduce the subtropical boundary layer cloud feedbacks of the global models within this column modelling framework. Therefore, this idealised set-up will be employed to examine the physical processes underlying the low-level cloud feedbacks of GCMs in climate change, to investigate their dependence on model parameterizations, and to assess their credibility by comparison with LES or cloud-resolving models (CRMs).

In addition LES and SCM experiments based on the stratocumulus and shallow cumulus regions in the Pacific Cross section will be forced with boundary conditions obtained from the future climate ESM experiments. The cloud response of these LES and SCM experiments will be compared with the cloud response of the ESMs in other to assess the credibility of the cloud response of the ESMs. This task 3.3 will be coordinated by Bjorn Stevens of MPG.

B.1.3.d Sensitivity Experiments & Hypothesis Testing (WP4)

The goal of this work-package is to develop and test hypotheses proposed to explain inter-model spread in cloud feedback and climate sensitivity in ESMs. By building on results from the other work-packages we here ask*: What have we (really) learned?* We intend to answer this question by creatively and rigoreously testing our deeloping ideas. This work-package will not only integrate ideas, but also methodologies. For this reason it will begin its activity before the activities of the other WPs are complete, in part to allow a seamless transition from the phase of idea development to the phase of idea testing, but also to develop familiarity with the diagnostic techniques being developed by the other work-packages. For practical purposes the work in this package will be broken down into tasks, which are discussed in more detail below. Because the specific nature of these tasks depends on the results of other work-packages, it should be appreciated that the work outlined here will be necessarily more vague than is the case for other work-packages.

B.1.3.d.1 Evaluate Unusual Behaviour

Anticipating that WP2 will identify modes of behaviour that are anomalous, or divergent; in this task we will focus on the development of methods for evaluating the origin and stability of these, anomalous, or divergent behaviours. The first sub-task will focus on the utility of NWP methods to identify the extent to which robust differences among models are evident at short times, as well as the varying utility of different methods. The second sub-task will use parameter sensitivity experiments to evaluate the robustness of the cloud-climate feedbacks. Both tasks will contribute to the identification of key uncertainties in cloud processes as well as methods (diagnostic techniques) for evaluating model improvements (or degradations).

Methodology and associated work plan

Task 4.1.1 will be lead by Mark Rodwell at the ECMWF. It will compare the 'Initial Tendency technique' developed by Rodwell and Palmer (2007) to the 'Transpose-AMIP' technique developed by Phillips et al. (2004). The former has the advantage of being able to identify biases that appear in the first six hours of a climate-resolution model forecast, before interactions with the resolved flow and non-linearities have had time to complicate the forecast error. The disadvantage is that it requires the forecasting model to have been employed within the data assimilation process (that is used to produce the initiating analyses). Hence this technique can, at present, only be applied to a few of the world's climate models (EC Earth, ARPEGE, UKMO, and depending on progress in the ongoing development of an assimilation system for ECHAM also this model). The Transpose-AMIP technique is more easy to apply, but is best suited to identifying errors that don't involve non-linear interactions with the evolving flow.

Task 4.1.2 will be lead by Bjorn Stevens at the MPI-M. Work will focus on the robustness of cloud-climate feedbacks to formulaic details in the ECHAM climate model, i.e., vertical discretization, time-stepping issues, parameter choices. Efforts in this task will take advantage of related work at MPG designed to address these questions. Key findings (for instance the resolution dependence or independence of cloud feedbacks) will be summarised in the form of hypotheses that will then be checked using other climate models in the EUCLIPSE ensemble; for instance EC-Earth which is a related model (both originate from different versions of the ECMWF model) and the French models (IPSL-ESM and Arpege). Sensitivity tests targeted at behaviour specific to the Hadley Centre model will also be performed and analysed. These tests will be chosen according to the particular issue under consideration.

B.1.3.d.2 Developing and Testing Parameterization Improvements

Attributing model behaviour (or sensitivity) to particular choices does not help one know which choice is correct. But it does tell you what choices to focus attention on. Thus work between WP3 and WP2 will help focus the activities of WP4, which will concentrate observational and modelling activities on those choices that play the largest role in setting a models cloud feedbacks. Using fine-scale or process models along with data from field experiments and monitoring activities (i.e., climate nodes, advanced atmospheric profiling sites, or satellite climatologies) to decide among different parameterization proposals, WP3 will identify specific proposals for improvements in the representation of parameterized physics. The effects of these improvements will be evaluated in WP4. Because it remains unclear what our choices will be in these respects, work on this task is outlined in the context of modifications to shallow and deep convection, and the role of aerosol effects. Recent experience with climate models that are operated in a NWP mode reveal that coupling the lateral mixing processes of the shallow and deep convection parameterizations to the tropospheric humidity have profound positive effects on the skill in tropical precipitation, MJO's and on reducing biases in pressure patterns in the extratropics. The impact of these type of new parameterizations will be evaluated on longer climatological timescales for the participating ESMs in EUCLIPSE.
. Depending on the outcomes of other work-packages the methodology in sub-task 4.2 will be refined, and (depending on time and need) extended to other parameterization choices.

Methodology and associated work plan

Task 4.2.1 will be lead by Roel Neggers at the KNMI. Here different proposals for representing shallow convection will be formulated in a manner that allows testing in single column models and full climate models. The range of diagnostic techniques, the suite of metrics, and the experimental configurations developed in other work packages will then be employed to test the idea that choices in the representation of shallow convection do indeed largely determine the character of the cloud-climate feedbacks of a given model. Work in this subtask will focus on the two or three EUCLIPSE models with the most divergent response in shallow convection, as for instance evident in the aqua-planet framework.

Task 4.2.2 will be lead by Ulrike Lohmann at the ETHZ. Work therein will evaluate the influence of specific aerosol-cloud interactions on cloud feedback, and vice versa. Using a subset of the EUCLIPSE models we will investigate cloud feedback with one-moment vs. two-moment cloud schemes. For the two-moment cloud scheme we shall use once present-day, once pre-industrial aerosol concentrations and once increased aerosol concentrations in Asia (or different realistic future aerosol scenarios). Here we will evaluate whether or not our ability to narrow the range in feedbacks of cloud processes narrows the spread in associated cloud-aerosol effects, and aerosol effects more broadly. Thus in this task one of the central hypotheses of EUCLIPSE will be addressed: Does a narrowing in uncertainty in cloud feedbacks reduce the uncertainty in the representation of other processes? Where in this case other processes means aerosol effects.

B.1.3.d.3 Establish Observational Metrics

When it comes to the cloud-climate feedback signal the ultimate test is the prediction itself. Do specific parameterization choices, or improvements, have observational proxies? For example, suppose that in the context of this proposal we identify more extensive stratocumulus regimes as the principle robust cloud feedback. Based on the model predictions, are there specific observations strategies, such as satellite observations, field or monitoring activities, which would allow one to associate changes in the system as a whole with changes in specific physical processes? Alternatively, if model choices can not be sufficiently narrowed based on processes and current-day understanding, can we identify the implications of equally plausible changes which may be observable before the effects of the feedback in its entirety become evident? Again an example: Suppose two representations of a cumulus mass flux closure are equally adequate descriptions of the available empiricism. How could the empiricism be expanded to decide among the two schemes? Or, what early warnings might we expect to detect to help us decide which of the two schemes better embodies changes within the system? These questions identify task 4.3 of this proposal.

Methodology and associated work plan

Task 4.3 will be lead by Johannes Quaas at the MPI-M. In this task we will build on task 4.2's findings on different parameterizations or parameter choices and their impact on simulated cloud-climate feedbacks. Based on the diagnostic techniques developed in the other work-packages and their results, we will investigate firstly whether and to which degree a particular diagnostic or metric allows to link differences among models in a particular cloud process parameterization to the simulated cloud-climate feedback. Where such a link can be identified, the observational constraints from the present-day climate are used to establish an improved estimate of the cloud-climate feedback and climate sensitivity based on the sensitivity studies in task 4.2. Where the diagnostics developed in the other WP yield ambiguous results, we will secondly analyse which additional diagnostics, new observations, or new monitoring strategies might allow for a better constraint.

B.1.3.1 Overall strategy and general description

EUCLIPSE is based on the plans developed in CFMIP2, makes use of and further develops techniques for model evaluation using the latest ground and space based remote sensing measurements, uses 5 leading European ESMs and 4 high resolution LES models for process-based analyses. In WP1 new diagnostic packages and satellite simulators are prepared and ESM simulations performed that are employed in the other WPs. WP2 evaluates the ESMs, assesses the cloud-climate feedbacks in present and future climate simulations and links the inter-model spread to the representation of cloud related processes. WP3 is guided by these analyses to perform dedicated high-resolution studies to develop physical understanding and guide improved representations of cloud related processes in the ESMs. WP4 synthesizes the results from WP2 and WP3 and designs metrics and performs sensitivity experiments to reduce the uncertainty in model-based assessments of future climate change. The results obtained in EUCLIPSE will feed into the next IPCC assessment report on climate change

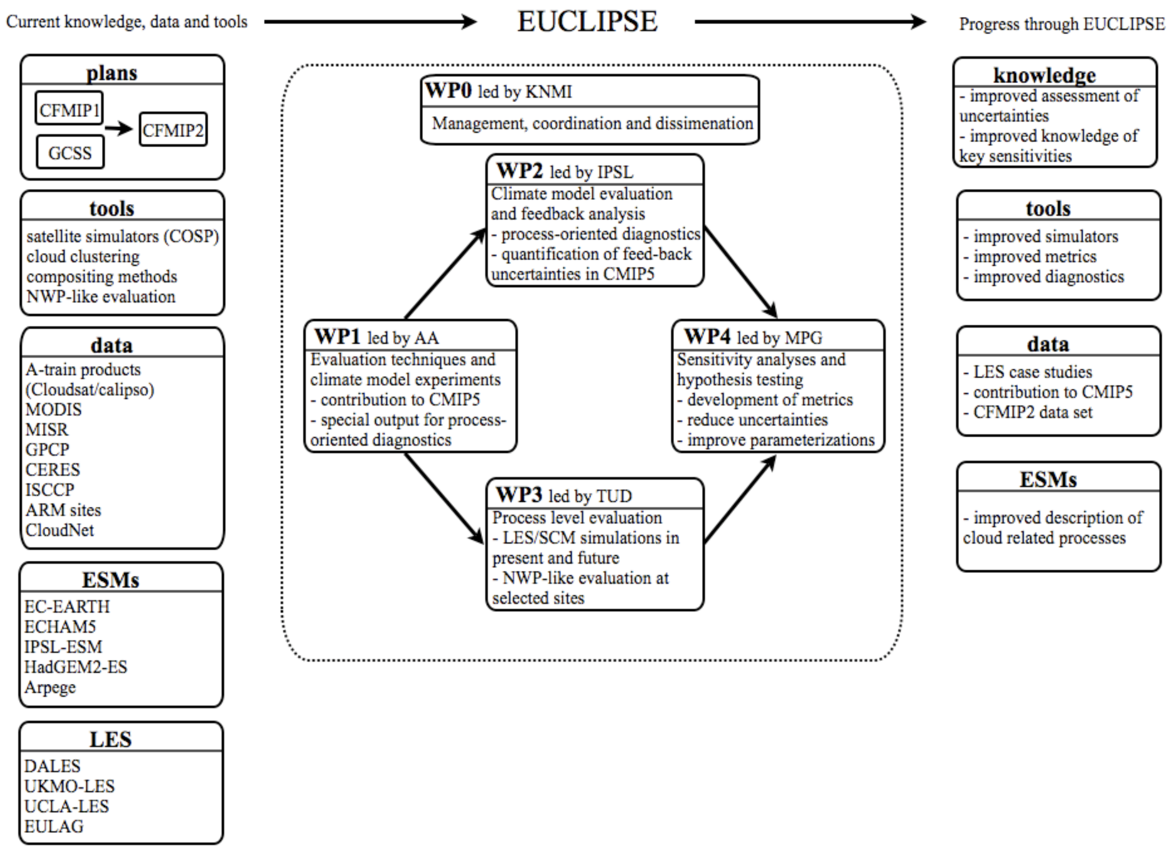


Figure 1.4 Perth chart showing the research strategy of EUCLIPSE in terms of the relations between the four Work Packages, the state-of-the-art from which EUCLIPSE starts and the progress that EUCLIPSE will bring about

B.1.3.1.a Significant risks, and associated contingency plans

a) General risks

EUCLIPSE is designed to make scientific process on critical evaluations of the most uncertain climate feedbacks associated with cloud related processes and how this influences precipitation processes and radiative transfer in ESMs. EUCLIPSE will deliver new model data sets with new diagnostics, new metrics and new evaluation tools and scientific progress aiming to understand and reduce the uncertainty associated with ESM predictions for future climate. All these goals are associated with risks.

Scientific work is generally risky, as no absolute certainty exists that all tasks of the project are completed successfully and in time. It is expected however that these risks are limited within EUCLIPSE because:

1. A careful planning of the project that started in fact already 2 years ago when representatives from GCSS and CFMIP has crossed their paths and started detailed planning of the project that has resulted in the CFMIP2 which has been approved and endorsed by several international organisations including WGCM, GEWEX and WGNE (see Figure 1.3 iv). The present EUCLIPSE project is building further and expanding on these plans and key persons from GCSS and CFMIP are part of the EUCLIPSE consortium.
2. Most participants have a long history in running EU projects and delivering top scientific results

b) Data Management Risks

The proposed ESM model runs and the proposed model diagnostics are part of CMIP5. As a result PCMDI has agreed to host the proposed model experiment results and agreements on data protocols are made between the EUCLIPSE partners and PCMDI (see Appendix B). To further enhance ensurance that the data dissemination will be guaranteed the data hosting will be as part of EUCLIPSE will be mirrored by DKRZ as part of the European FP7 IS-ENES and METAFOR projects. DKRZ will also host additional model experiments in EUCLIPSE and be responsible for data quality control during the project. The LES model experiments will be hosted by the DIME site. DIME has within GCSS a long history in hosting high resolution model data including the descriptions of the set up of experiments and the observational data.

c) Scientific risks

EUCLIPSE has ambitious scientific goals on a long and outstanding problem in climate modelling. It will limit risks through:

- Having world leading scientists on all topics covered by the consortium (ESM modelling, observations, evaluation techniques and high resolution modelling)
- Having representatives of the scientific stakeholders of international organisations (WCRP, WGNE) and observational platforms (CloudNet, CloudSat) in its advisory board.
- Including 5 ESMs and 4 LES models in its consortium as to decrease the risk that ill-posed conclusions might be drawn due singular behaviour of one specific model configuration.

c) Recruitment risks

EUCLIPSE will give opportunity to numerous scientists, both at post-doc level and at PhD level to be active in the project. Recruitment for temporal personnel in the field of climate research is getting more difficult and time consuming as there is an increasing demand for scientists on this topic in the current market. In order to keep this risk small, participants will:

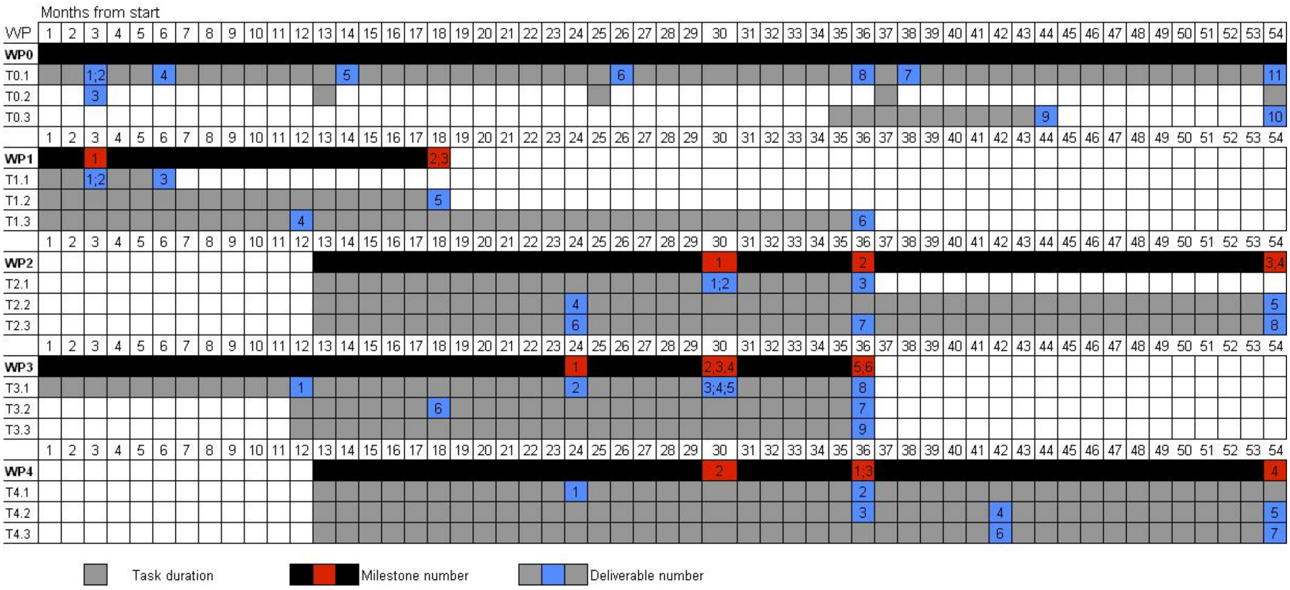
- Make sure that permanent staff at the partner institutions are experts on the key activities
- Already starting the planning of recruitment of personnel through the different advertisement channels

- Agree to communicate in time to the coordinator if there are delays in the recruitment procedures, so that alternative solutions can be considered.

d) Management risks

The coordinator and the project office will be responsible for the monitoring of the risk factors listed above. If delays or deviations of the project plan are identified, the coordinator will take action to seek solutions with the involved partner. This will be done using the management structure through contacting the Manage Board (MB), the advisory board or the financial administration of the European Commission. In case of a conflict with a partner concerning the delivery of a task, the dispute will be first handled by the WP leader. If no satisfactory solution is achieved, the MB wil develop a strategy and intervene in the dispute with the possibility of sanctions. In case of disagreement in the MB, the coordinator will take the final decision and will be responsible for its execution. The coordinator will report the case, the solution and its consequences to the EC appointed project officer.

B.1.3.2 Timing of work packages and their components



WP0	Management
T0.1	Project Management
T0.2	Annual general assemblies and project meetings
T0.3	International Workshop

WP1	Evaluation techniques and climate model experiment
T1.1	CFMIP Observation Simulator Package (COSP)
T1.2	Collection, assessment and improvement of evaluation techniques
T1.3	ESM simulations and diagnostics

WP2	Climate Model Evaluation and Analysis
T2.1	Metrics, Evaluation of cloud related processes in ESMs
T2.2	Influence of Cloud Representation in ESMs on prominent features of current climate
T2.3	Cloud-radiative feedbacks and precipitation responses in ESMs for future climate

WP3	Process Level Evaluation
T3.1	Evaluation of case studies with LES and SCMs
T3.2	Evaluation of ESMs on selected locations
T3.3	Analysis of LES and SCM experiments for future climate

WP4	Sensitivity Experiments and Testing Hypotheses
T4.1	Establishment of process stability
T4.2	Physical process uncertainty within models
T4.3	Identification of observables and inferences

Table 1.3.2 Timetable of the duration of the Workpackages and Tasks, and including the dates of the milestones and deliverables.

It is envisioned that a number of specific deliverables of EUCLIPSE will be used as input for the Fifth Assessment Report (AR5) of the IPCC, either directly as peer reviewed articles and reports or indirectly through the submission of model runs to the coupled model inter-comparison project (CMIP-5). The timelines of AR5, CMIP5 and EUCLIPSE and the connections between EUCLIPSE to AR5 and CMIP5 are specified in Fig. 1.5. It should be mentioned that the EUCLIPSE deliverables of WP2 and WP3 are planned later than the deadline for paper submission for AR5. However given the importance of AR5 an extra effort in EUCLIPSE will be made to have articles and manuscripts ready well before the AR5 deadline

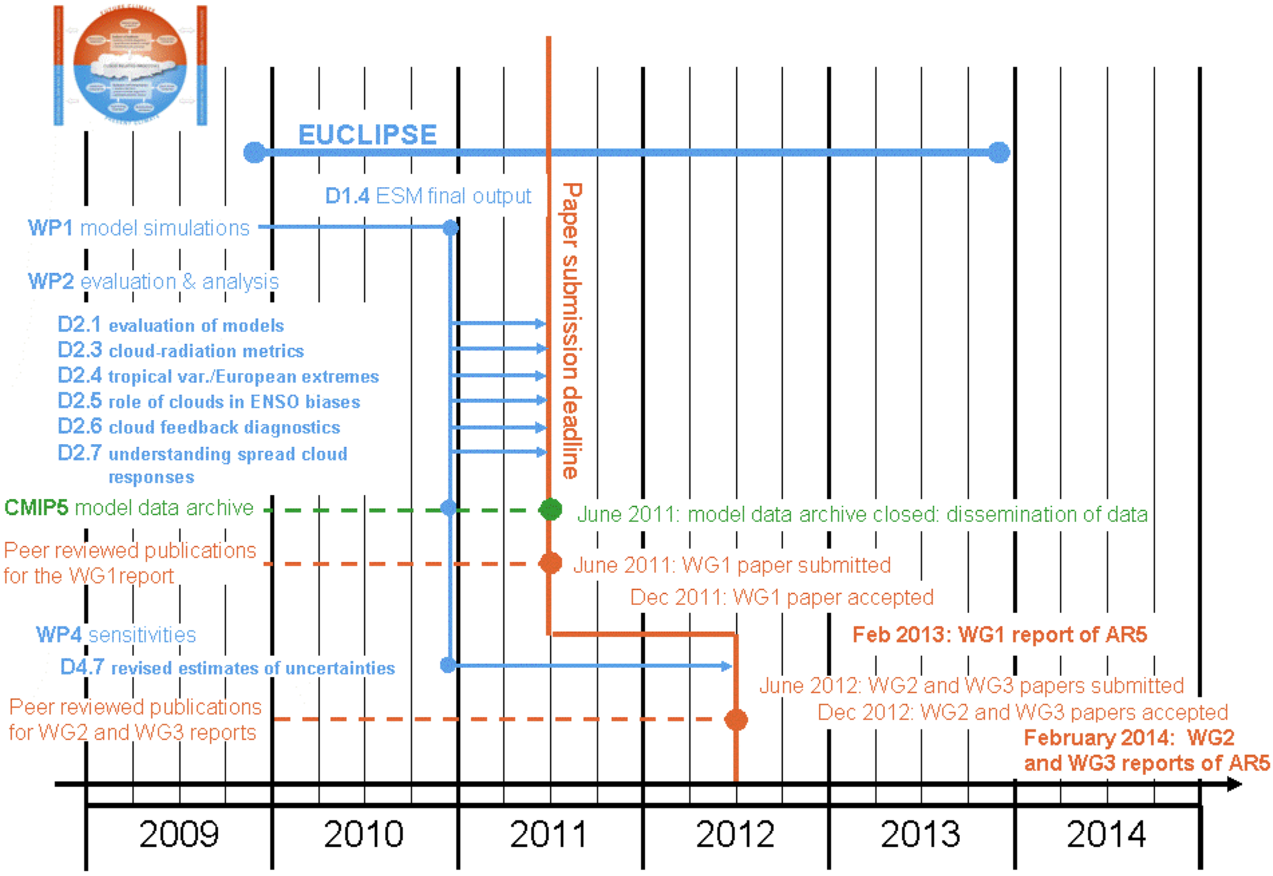


Fig 1.5 Timelines of EUCLIPSE, AR5 and CMIP5 and the flow of deliverables from EUCLIPSE into AR5 and CMIP5.

B.1.3.3 Work package list / overview

Work package list

Work package No[2]	Work package title	Type of activity[3]	Lead beneficiary No[4]	Person-months[5]	Start month[6]	End month[7]
WP0	Management	MGT	1	29	1	54
WP1	Evaluation Techniques and Climate Model Experiments	RTD	5	75	1	36
WP2	Climate Model Evaluation and Analysis	RTD	4	144	13	54
WP3	Process Level Evaluation	RTD	7	136	1	36
WP4	Sensitivity Experiments and Hypothesis Testing	RTD	2	127	13	54
	TOTAL			511		

2 Workpackage number: WP 1 – WP n.

3 Insert one of the following 'types of activities' per WP:

RTD = Research and technological development including scientific coordination applicable for collaborative projects and NoEs

DEM = Demonstration - applicable for collaborative projects

OTHER = Other activities (including management) applicable for collaborative projects, NoEs, and CSA

MGT = Management of the consortium - applicable for all funding schemes

4 Number of the beneficiary leading the work in this work package.

5 The total number of person-months allocated to each work package.

6 Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

7 Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

B.1.3.4 Deliverables list

List of Deliverables – to be submitted to EC[8]

Del. no. [9]	**Deliverable name**	**WP no.**	**Lead beneficiary**	***Estimated indicative person-months***	**Nature**[10]	**Dissemi-nation level**[11]	**Deli-very date**[12]
D0.1	Project Flyer	0	KNMI	1	O	PU	3
D0.2	Internal web site	0	KNMI	2	O	RE	3
D0.3	Kick-off Meeting	0	KNMI	1	O	PU	3
D0.4	Public web site	0	KNMI	2	O	PU	6
D0.5	Year 1 report	0	KNMI	2	R	RE	14
D0.6	Year 2 report	0	KNMI	2	R	RE	26
D0.7	Year 3 report	0	KNMI	2	R	RE	38
D0.8	Brochure	0	KNMI	2	R	PU	36
D0.9	Summer School	0	KNMI	4	O	PU	44
D0.10	Edited book	0	MPG	4	O	PU	54
D0.11	Final report	0	KNMI	4	R	RE	54
D0.12	Final plan for the use and dissemination of foreground	0	KNMI	1	R	PU	54
D0.13	Final Report on “Awareness and Wider Societal Implications	0	KNMI	1	R	PU	54
D0.14	Vision Paper on future research issues in relation to climate change	0	KNMI	0.5	R	PU	54
D0.15	Policy brief on implications of the project results on the climate decision making process.		KNMI	0.5	R	PU	54
D1.1	Final version of COSP	1	METO	2	O	PU	3

8 In a project which uses ‘Classified information[8]’ as background or which produces this as foreground the template for the deliverables list in Annex 7 has to be used

9 Deliverable numbers in order of delivery dates: D1 – Dn

10 Please indicate the nature of the deliverable using one of the following codes:
R = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

11 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)

12 Month in which the deliverables will be available. Month 1 marking the start date of the project, and all delivery dates being relative to this start date.

	software						
D1.2	Final versions of CALIPSO-PARASOL observational analysis product and of MODIS simulator.	1	MPG	6	O	PU	3
D1.3	ESM versions with COSP software	1	METO	9	O	PU	6
D1.4	Final output of ESM simulations	1	METO	16	O	PU	12
D1.5	Final versions of model evaluation packages	1	AA	24	O	PU	18
D1.6	Reprocessed version of EUCLIPSE model data products for long-term archiving within WDCC beyond the runtime of the project	1	DKRZ	18	O	PU	36
D2.1.	Evaluation of clouds, radiation and precipitation in ESMs using COSP, clustering and compositing techniques.	2	METO	38	R	PU	30
D2.2	Report on the evaluation of cloud-aerosols-radiation interactions in ESMs	2	MPG	10	R	PU	30
D2.3	Design and application of a set of metrics that synthesises the ability of climate and weather prediction models to simulate clouds, precipitation and radiation	2	METO	32	O	PU	36
D2.4	ESM evaluation of the ITCZ, the intra-seasonal and inter-annual variability of the tropical atmosphere, and temperature extremes over Europe	2	MF-CNRM	12	R	PU	24
D2.5	Establish links between the representation of cloud and moist processes in ESMs and their ability to simulate the ITCZ, MJO and ENSO, and temperature extremes over Europe	2	MF-CNRM	12	R	PU	54
D2.6	Diagnostic of the climate feedbacks, including global and regional spreads, produced ESMs and of cloud and precipitation	2	CNRS-CNRS-IPSL	18	R	PU	24

	responses to climate change for CMIP5 runs; comparisons with estimates from the CMIP3 models						
D2.7	Identification of the processes or cloud types most responsible for the spread in climate change cloud feedbacks and precipitation responses	2	CNRS-IPSL	12	R	PU	36
D2.8	Interpretation of the spread of cloud and precipitation responses among models, in interaction with WP3 and WP4	2	METO	10	R	PU	54
D3.1	Description of the set-up for the ASTEX, the GPCI stratocumulus and shallow cumulus, and the SCM equilibrium state cases	3	TUD	12	O	PU	12
D3.2	Storage of instantaneous 3D LES fields and key statistical variables in a public archive	3	TUD	6	R	PU	24
D3.3	Detailed analyses of the LES and SCM results for ASTEX and the two GPCI columns	3	TUD	30	O	PU	30
D3.4	Identification and comparison of the key quantities used in ESM parameterization schemes with LES results and observations	3	TUD	16	R	PU	30
D3.5	SCM equilibrium states in the Hadley circulation	3	TUD	8	R	PU	30
D3.6	Results at selected grid points (GCPI/CloudNet/ARM/AMMA)	3	KNMI	22	O	PU	18
D3.7	Comparison of the hydrological and energy balance and the cloud amount as computed by ESMs	3	MF-CNRM	10	R	PU	36
D3.8	Development and application of methods to exploit high frequency for understanding cloud feedbacks	3	METO	16	R	PU	36
D3.9	Quantification of the cloud-climate feedback and its uncertainty for prescribed large-scale conditions	3	MPG	16	R	PU	36
D4.1	A developing database and	4	MPG	14	O	PU	24

	protocol for parameter and structural (numerical) sensitivity studies						
D4.2	Comparison study of the model sensitivity to the numerical structure of the computations (grid and time step) with the parameter sensitivity of the model.	4	MPG	18	R	PU	36
D4.3	Report on a study identifying the utility of NWP based methods for identifying and narrowing sources of divergent behaviour in cloud-climate feedbacks in ESMs	4	ECMWF	24	R	PU	36
D4.4	New process representations to be implemented in ESMs which will rationalise the range of responses by the models	4	KNMI	17	P	PU	42
D4.5	Evaluation to what extend aerosol-cloud-climate effects depend on the representation of cloud processes.	4	ETHZ	12	R	PU	54
D4.6	Process-related metrics that can be used as model development and evaluation tools	4	MPG	26	P	PU	42
D4.7	Revised estimates, with uncertainty bounds, of climate sensitivity from EUCLIPSE ESM ensemble	4	MPG	16	R	PU	54
			TOTAL	511			

B.1.3.5 Work package descriptions

Detailed descriptions for each work package are specified below in tabular form. The tables include information on the participants, the invested person months, the objectives, the description of work and the related deliverables.

Work package number	WP0	**Start date or starting event:**		1			
Work package title	Management						
Activity Type[13]	MGT						
Participant number	1						
Participant short name	KNMI						
Person-months per participant:	29						

Objectives

- Manage efficiently the project.
- Communication between the European Commission and EUCLIPSE, including all forms of reporting specified in the consortium contract agreement.
- Provide the communication tools for the project: public and internal web sites.
- Organise annual general assemblies and project meetings.
- Organise a EUCLIPSE international dissemination Workshop.
- Ensure promotion of clustering and cooperation with related projects (both in FP7 and other international and national projects).

Description of work

T0.1: Project Management

The coordinator supported by the Project officer and the administrative staff are in regular contact with the Management Board of EUCLIPSE and the European Commission. The project office will prepare the necessary scientific and financial reports for the EC. The project office will communicate all necessary information from the EC to the participants for the preparation of the due reports and for the financial aspects. The project will set up and maintain a public and an internal project website.

T0.2: Annual general assemblies and project meetings

13 Please indicate one activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium; OTHER = Other specific activities, if applicable (including any activities to prepare for the dissemination and/or exploitation of project results, and coordination activities).

The project office prepares the general assemblies and project meetings. Together with the SSC, the project office produces the programme of the meeting, invites the advisory board, international guest speakers, and representatives from other related projects (FP7 projects and international projects).

T0.3: Dissemination Activities

The project office will actively promote dissemination activities. It will make sure that all observational and model data, evaluation tools and the scientific knowledge acquired in EUCLIPSE are freely available for external users. This will be done through promotion of the EUCLIPSE achievements, tools and data in meetings of national and international organisations and through a EUCLIPSE organised summer school in the 4th year for a wide scientific audience. The project office will produce a flyer and a brochure.

Deliverables (brief description and month of delivery)

D0.1: Project Flyer (KNMI, Month 3)

D0.2: Internal web site (KNMI, Month 3)

D0.3: Kick-off Meeting (KNMI, Month 3)

D0.4: Public Web Site (KNMI, Month 6)

D0.5: Year 1 report (KNMI, Month 14)

D0.6: Year 2 report (KNMI, Month 26)

D0.7: Year 3 report (KNMI, Month 38)

D0.8: Brochure on the results of the EUCLIPSE (KNMI, Month 40)

D0.9: International summer school on the achievements of EUCLIPSE and on the use of the evaluation tools and the observational and model data in EUCLIPSE (KNMI, Month 44)

D0.10: Edited book with lectures from the summer school (MPG/KNMI, Month 54)

D0.11: Final Report (KNMI, Month 54)

1. **Work package number**	WP1		**Start date or starting event:**			Month 1	
Work package title	Evaluation Techniques and Climate Model Experiments						
Activity Type[14]	RTD						
Participant number	1	2	3	4	5	8	13
Participant short name	KNMI	MPG	METO	CNRS -IPSL	AA	MF-CNRM	DKRZ
Person-months per participant:	6	4	9	4	24	10	18

Objectives

- Complete the development of the CFMIP Observation Simulator Package (COSP) and implement the package in the code of the ESMs that are participating in CMIP-5 and CFMIP-2.
- Collect existing model evaluation techniques and assess them in terms of their ability to resolve atmospheric processes responsible for cloud formation and water cycling. Improve existing techniques and make them available for application to observational retrievals and to EM output.
- Execute a suite of ESM simulations that include current-climate conditions, perturbed climate warming conditions, and idealised aqua-planet simulations. Implement model diagnostics packages that facilitate the application of process-based model evaluation techniques. Ensure cooperation with related projects, both in FP7 and in other international and national projects.

Description of work

The evaluation of ESMs using process-based techniques is extremely important since it both increases our understanding of the processes responsible for model deficiencies and facilitates the task of model improvement. The success of process-based model evaluation methods relies on the development of advanced model analysis tools, the selection of suitable model simulation specifications, and the storing of the proper model diagnostics from those simulations. This WP addresses those issues in ways that will facilitate the model evaluation work that will be performed in WP2 and the process studies that will be performed in WP3.

In order to achieve the WP objectives detailed above the work is separated into three primary tasks.

T1.1: Completion and Implementation of the CFMIP Observation Simulator Package (COSP)

The CFMIP Observation Simulator Package (COSP) is a software package that aims to create model output diagnostics that can be directly compared to satellite retrievals of cloud and other atmospheric properties. Currently the package consists of three modules that simulate the ISCCP cloud dataset and the CloudSat- and CALIPSO-PARASOL-retrieved quantities. In the context of WP1 EUCLIPSE participants will also produce "GCM-oriented products" from CALIPSO and PARASOL satellite observations as well as a MODIS simulator imbedded in the COSP framework.

Task 1.1.1: *Continuing COSP development*. The first production version of COSP is nearly completed and will be released in early 2009. This task will concentrate on minor upgrades/improvements to the software to ensure easy application to the participating CFMIP-2 ESMs, as well as on computational optimisation.

Partners: **METO**, CNRS-IPSL

Task 1.1.2: *Development of "GCM-oriented products" from CALIPSO and PARASOL satellite observations*

[14] Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium; OTHER = Other specific activities, if applicable (including any activities to prepare for the dissemination and/or exploitation of project results, and coordination activities).

that will be fully consistent with the diagnostics derived from the CALIPSO and PARASOL simulators included in COSP

Partners: **CNRS-IPSL**

Task 1.1.3: *Implementation of COSP to participating EUCLIPSE climate models*. COSP has been designed so that it can be run off-line or in-line. The off-line mode is only suitable for short experiments as it requires a large volume of input data. Its in-line implementation is recommended for longer experiments. This task will focus on the in-line implementation of COSP in the participating climate models.

Partners: KNMI, MPG, **METO**, CNRS-IPSL, MF-CNRM

Task 1.1.4: *Implementation of a MODIS simulator within the COSP framework*. This MODIS simulator would not simulate radiances, but rather the daily 2D cloud-top fields as seen by the passive instrument.

Partners**: MPG**

Task 1.2: Collection, assessment, and improvement of process-based model evaluation techniques

In the last decade, several methods have been developed that aim to evaluate model cloud, radiation, and precipitation properties in a process-oriented manner. They include compositing techniques, where one or more properties of the atmosphere are used to define atmospheric states on which cloud, radiation, and precipitation properties are composited, and clustering techniques where properties of the cloud field are used to define distinct groupings of cloud types that form distinct cloud systems. In both cases, the main idea is to break up the complex cloud, radiation, and precipitation fields into clusters where a certain combination of atmospheric processes dominates the cloud and rain formation process. With the help of observational simulators those techniques are applied to cloud properties from both observational retrievals and from model output. Then, model deficiencies that are detected can be attributed to the specific process or processes that are dominant in the deficient cloud system. Several of the participants in this proposal have developed and applied such techniques and the proposed work provides the opportunity to evaluate them, apply improvements to them, and examine their combined application to ESM output.

Task 1.2.1: The task will start with a *survey of existing model evaluation techniques* that put emphasis in resolving the processes involved in cloud formation and water cycling. An analysis of the different techniques will be performed in order to better understand and document the atmospheric processes that they resolve and the degree to which they resolve them.

Partner: **AA**

Task 1.2.2: Since several of the compositing and clustering techniques have been developed by participants in this proposal, *changes and improvements will be applied to those techniques* with two primary objectives. The first is to improve the degree to which the techniques resolve the cloud formation and water cycling processes and the second is to examine ways to apply combinations of different techniques on ESM output. The resulting evaluation packages will be made available to WP2, WP3, and WP4 for model output analysis and evaluation work.

Partner: **AA**

Task 1.3: Execution of ESM simulations and implementation of model diagnostics

A hierarchy of ESM experiments will be performed that are building on experiments already being proposed in the context of CMIP-5. The experiments include present climate conditions and perturbed climate warming simulations, as well as idealized aqua-planet runs. This suite of experiments will help isolate first the relationships between atmospheric processes and cloud and water properties in current climate conditions and second changes in those properties and the resulting cloud and precipitation changes in climate warming conditions.

Task 1.3.1: *A suite of simulations will be executed by all participating ESM groups.* Models will be run with atmosphere-only configurations and with prescribed Sea Surface Temperature (SST) patterns. The experiments include: a) Control AMIP simulations using interannually varying observed SSTs, b) ‘Hansen’ CO2 forcing experiments with SSTs from the control run and 4xCO2, c) SST perturbation experiments using a pattern based on a composite of CMIP3 AOGCM CO2 quadrupling experiments, d) uniform +4K SST perturbations e) Aqua-planet experiments using an idealised zonal mean climatology for the control, with 4xCO2 and uniform +4K perturbation experiments. A number of experimental simulations will be performed by a few of the participating groups that will include simulations of a few days and day-to-day comparisons with observations.

Besides the standard model output, a set of additional diagnostics will be saved from the runs. The selection of those diagnostics is justified by published studies that demonstrate the effective use of the requested outputs. The main objectives are to maximise the opportunities for use of the model output in model evaluation and model improvement studies and to maximise the use of satellite observations in model evaluation efforts. The output of the WP1 simulations will form the basis for the model analysis and evaluation work in WP2.

Partners: KNMI, MPG, **METO**, CNRS-IPSL, MF-CNRM

Task 1.3.2: EUCLIPSE model output will be inserted in the WDCC database system. Project data curation includes dissemination of CMIP-5 data products to project partners and augmentation of the CMIP-5 database by GCM and cloud resolving simulations from EUCLIPSE. Data and metadata ingestion into the WDCC database system will use the CMIP5 data interfaces and should therefore be of no problem for each modelling partner. WDCC data quality insurance includes data collection, check of metadata and data structures against WDCC ingest interfaces and exceptions handling during ingest process (metadata and data). EUCLIPSE relevant data will be documented and disseminated via a web-based data portal.

Partners: KNMI, MPG, METO, CNRS-IPSL, MF-CNRM, **DKRZ**

Deliverables (brief description and month of delivery)

D1.1: Final version of COSP software (Month 3).

D1.2: Final versions of CALIPSO-PARASOL observational analysis product and of MODIS simulator (Month 3).

D1.3: ESM versions with COSP software implemented (Month 6).

D1.4: Final output of ESM simulations (Month 12).

D1.5: Final versions of model evaluation packages (Month 18).

D1.6: Reprocessed version of EUCLIPSE model data products for long-term archiving within WDCC beyond the runtime of the project (Month 36).

Work package number	WP2	**Start date or starting event:**	Month 1

Work package title	Climate Model Evaluation and Analysis						
Activity Type[15]	RTD						
Participant number	1	2	3	4	5	8	9
Participant short name	KNMI	MPG	METO	CNRS-IPSL	AA	MF-CNRM	SU
Person-months per participant:	24	10	24	32	12	12	24
Participant number	13						
Participant short name	DKRZ						
Person-months per participant:	6						

Objectives

- *To evaluate the simulation of clouds, precipitation and radiation by climate and weather prediction models*, point out systematic and compensating errors, and develop cloud metrics.
- *To investigate whether and how the simulation of cloud and moist processes influences the simulation of the current climate*, in particular the mean tropical precipitation and large-scale circulation, the tropical variability at intra-seasonal and inter-annual timescales, and the simulation of temperature extremes over Europe.
- *To quantify and to interpret the inter-model spread of climate sensitivity estimates and of the cloud and precipitation responses to climate change predicted by ESMs*, to identify the regions, the cloud regimes and the meteorological conditions primarily responsible for this spread, and to explore the mechanisms that control this response in the different models.

Task 2.1: Apply observational and process-oriented diagnostics defined in WP1 and define metrics to evaluate the representation of clouds, precipitation and radiation by ESMs

Task 2.1.1: *Evaluate the tri-dimensional distribution of clouds simulated by climate models* by comparing COSP outputs with satellite observations from passive (ISCCP, PARASOL, MODIS, AVHRR) and active (CALIPSO, CloudSat) instruments. Point out systematic errors in the simulation of clouds and radiation (from the Tropics to the Arctic), and unravel compensating errors (e.g. between the predicted cloud fraction and cloud optical thickness) in the simulation of top-of-atmosphere radiative fluxes.

Partners: MPG, **METO**, CNRS-IPSL, AA, MF-CNRM, SU, KNMI

Task 2.1.2: *Use compositing and clustering techniques to evaluate the ability of GCMs to simulate the precipitation and the radiative impact associated with specific cloud types and dynamical regimes.* Relate the GCM's errors in the simulation of specific cloud types to the deficiencies pointed out at the process-level.

Partners: METO, CNRS-IPSL, **AA**

Task 2.1.3: *Evaluate cloud-aerosol-radiation interactions* by using COSP and MODIS satellite data, and by comparing observed and simulated statistical relationships between aerosol concentration, cloud properties, and top-of-the-atmosphere radiation for individual regions, cloud types and dynamical regimes.

Partners: **MPG**, CNRS-IPSL

Task 2.1.4: *Develop a set of metrics that synthesise the ability of climate and weather prediction models to*

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[15] Please indicate one activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium; OTHER = Other specific activities, if applicable (including any activities to prepare for the dissemination and/or exploitation of project results, and coordination activities).

simulation of clouds, precipitation and radiation. First apply existing state-of-the-art metrics to CMIP5 simulations. Then develop new metrics based on the diagnostics developed in Tasks 2.1.1 and 2.1.2.

Partners: KNMI, MPG, **METO**, CNRS-IPSL, AA, MF-CNRM, SU

Task 2.1.5: *Integration of data analysis workflows with respect to cloud processes into the WDCC infrastructure.* In addition to exiting CMIP-5 data metrics data diagnostics which will be developed within EUCLIPSE will be inferred with respect to integration into the standard data processing workflows of WDCC.

Partners: **DKRZ**

Task 2.2: Examine the influence of the representation of cloud and moist processes in the simulation of a few prominent features of the current climate

Task 2.2.1: *Role of cloud and moist processes in the simulation of the ITCZ and in tropical intra-seasonal variability (MJO):* Use the set of metrics recently developed by CLIVAR to assess the ability of GCMs to simulate the observed characteristics of the MJO in different CMIP5 simulations (coupled, atmospheric, aquaplanet); Relate the ability of GCMs to simulate a single or double ITCZ and intra-seasonal variability to their ability to simulate convection-humidity feedbacks, cloud-radiation feedbacks, the transition between dry and moist precipitating regimes and the stratiform or convective types of precipitation.

Partners: KNMI, CNRS-IPSL, **MF-CNRM**

Task 2.2.2: *Role of cloud and moist processes in the simulation of tropical inter-annual variability (ENSO):* Use the set of metrics recently developed by CLIVAR to assess the ability of GCMs to simulate the observed characteristics of ENSO in CMIP5 simulations; Apply process-based diagnostics of the dynamical and heat flux feedbacks involved in ENSO to understand the diversity of ENSO behaviour among models, and relate the heat-flux feedbacks simulated by models to the simulation of clouds, convection and radiation and their interaction with SST.

Partners: MPG, **CNRS-IPSL**, MF-CNRM

Task 2.2.3: *Role of cloud processes in the simulation of temperature extremes over Europe:* Assess the ability of GCMs to simulate heat waves and cold spells over Europe, analyse the occurrence of temperature extremes as a function of weather regimes, and use the ISCCP simulator to diagnose the cloud variability associated with these regimes; Compare the performance of GCMs in AMIP simulations where the large-scale circulation is predicted by the model or nudged by ERA-interim analyses; Infer the relative roles of large-scale dynamics, cloud variations and regional processes such as land surface hydrology in the simulation of temperature extremes over Europe.

Partners: KNMI, MPG, CNRS-IPSL, **MF-CNRM**

Task 2.3: Quantify, analyse and interpret the diversity of cloud-radiative feedbacks and precipitation responses produced by climate models in climate change simulation

Task 2.3.1: *Diagnose the different climate feedbacks* associated with clouds, water vapour, temperature lapse rate, surface albedo and quantify the contribution of each feedback to the inter-model spread of climate sensitivity estimates; Compare this spread of current (CMIP5) models with that of the previous generation of climate models (CMIP3). Quantify the spread of temperature, precipitation and cloud responses to climate change at the regional scale.

Partners: METO, **CNRS-IPSL**

Task 2.3.2: *Identify the processes, the cloud types or environmental situations that are primary responsible for the spread of the global cloud and precipitation responses.* Determine whether the response of low-level clouds is still an important contributor to the spread of climate sensitivity estimates in CMIP5 models.

Partners: KNMI, **METO**, CNRS-IPSL, AA

Task 2.3.3: *Refine the identification of the processes or cloud types primarily responsible for the spread* of cloud and precipitation responses by comparing these responses in a suite of experiments performed by GCMs in simplified or idealised (aqua-planet) configurations; Isolate and understand the effects of CO2 radiative forcing, or surface warming and of resultant circulation changes on clouds and precipitation; Hierarchise the relative importance of different processes in the robust responses of clouds and precipitation to climate change.

Partners: KNMI, MPG, METO, **CNRS-IPSL**, MF-CNRM

Deliverables (brief description and month of delivery)

Associated with Task 1:
D2.1: Report on evaluations of clouds, radiation and precipitation simulated by climate models using COSP, clustering and compositing techniques developed in WP1 and satellite observations (Month 30).

D2.2: Report on the evaluation of cloud-aerosols-radiation interactions in ESMs (Month 30).

D2.3: Design and application of a set of metrics that synthesises the ability of climate and weather prediction models to simulate clouds, precipitation and radiation (Month 36).

Associated with Task 2:
D2.4: Report on the ability of models to simulate the ITCZ, the intra-seasonal and inter-annual variability of the tropical atmosphere, and temperature extremes over Europe using a new set of diagnostics (Month 24).

D2.5: Report on the influence of the representation of cloud and moist processes in models (based on D1.4, D2.3 and WP3) on the simulation of the ITCZ, MJO and ENSO, and temperature extremes over Europe (Month 54).

Associated with Task 3:
D2.6: Report on the diagnostic of the climate feedbacks produced by the different models in some CMIP5 simulations; Report on the global and regional spreads of feedbacks and of cloud and precipitation responses to climate change; and their comparison with estimates from the CMIP3 models (Month 24).

D2.7: Report on the identification of the processes or cloud types most responsible for the spread in climate change cloud feedbacks and precipitation responses (Month 36).

D2.8: Report on the interpretation of the spread of cloud and precipitation responses among models, in interaction with WP3 and WP4 (Month 54).

Work package number	WP3	**Start date or starting event:**					Month 1	
Work package title	Process-Level Evaluation							
Activity Type[16]	RTD							
Participant number	1	2	3	4	5	7	8	11
Participant short name	KNMI	MPG	METO	CNRS -IPSL	AA	TUD	MF-CNRM	UW
Person-months per participant:	15	10	9	10	4	54	16	24

Objectives

- To conduct dedicated high resolution simulations with Large Eddy Simulation (LES) models and SCMs that will provide further insight in the cloud dynamical processes
- To evaluate ESMs experiments with observations for key cloud regimes on selected locations for present climate
- To analyse the response of boundary layer clouds in idealised and future climate conditions through the use of LES models and SCMs

Description of work

Task 3.1: Evaluation of boundary-layer cloud processes with fine-scale models and observations

Large-eddy and single-column model simulations will be made of stratocumulus and shallow cumulus cloud fields. The first case is based on an observed stratocumulus to cumulus transition during ASTEX and investigates whether ESM models are capable to represent two different cloud types in one grid column, or that one of either cloud types dominates the model solution. The second case addresses a stratocumulus and a shallow cumulus case at two locations selected from the GEWEX Pacific Cross Section Intercomparison Study. The aim is to identify the most critical parameters in ESMs that control cloud amount and cloud fraction. In turn, these quantities will be compared to observations and LES results. In the third set the effect of the large-scale divergence of the mean horizontal winds on (quasi-) equilibrium states of SCMs will be investigated. This exercise will provide insight in systematic differences in the boundary-layer cloud representation in the subtropical part of the Hadley circulation by ESMs.

Task 3.1.1: *Set up of the ASTEX and GPCI cases*. The ASTEX case will be determined from aircraft and ECMWF reanalysis data (Bretherton et al. 1999; De Roode and Duynkerke 1997). Select two GPCI columns on the basis of a maximum frequency of occurrence of shallow cumulus and stratocumulus, respectively. Obtain the mean large-scale forcings from ECWMF reanalysis data. In addition, determine more realistic time-dependent large-scale forcings on the basis of results from the participating ESMs.

Partners: METO, **TUD, MPG**, UW

Task 3.1.2: *Simulate the ASTEX and the two GPCI cases with SCMs and LES models*. Use the LES results to

[16] Please indicate one activity per work package:
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compute quantities that are used in turbulence and microphysics parameterization schemes in the ESMs. Save snap-shots of instantaneous 3D LES fields of (thermo-)dynamical quantities for storage in a public archive. Analyse and interpret the SCM results to identify of the most critical parameters in SCMs that control the cloud amount and cloud fraction in the simulations. In turn, compare these findings to LES results and observations.

Partners: CNRS-IPSL, METO, **TUD**, MPG, UW, MF-CNRM

Task 3.1.3: *Run SCMs to (quasi-)equilibrium states for a range of different values for the large-scale divergence of the horizontal winds and the SST.* Use the results to analyse the cloud-top height, cloud liquid water path, cloud fraction, and drizzle rate. Identify the key quantities that control these quantities.

Partners: CNRS-IPSL, **TUD**, MF-CNRM, MPG

Task 3.2 Analysis of ESMs results (both free and NWP-constrained) and comparison to observations at selected locations

To allow a comparison with field data high frequency data from ESM results for the following locations: GPCI / ARM / CloudNet / AMMA. The ESM data will be obtained both from free climate and NWP-constrained modeling results.

Task 3.2.1: *Collect output from ESMs for the GEWEX Pacific Cross Section (GPCI) and compare the results with observations and satellite retrievals.* Emphasis will be put on the energy balance, the hydrological balance and cloud amount in the respective atmospheric columns.

Partners: **KNMI**,, AA, CNRS-IPSL

Task 3.2.2: *Collect output from ESMs for CloudNet and ARM sites and compare the results with observations and satellite retrievals.* Emphasis will be put on the energy balance, the hydrological balance and cloud amount in the respective atmospheric columns.

Partners: **KNMI**, CNRS-IPSL, AA

Task 3.2.3: *Collect output from ESMs for the AMMA transect and compare the results with observations and satellite retrievals*. Emphasis will be put on the energy balance, the hydrological balance and cloud amount in the respective atmospheric columns.

Partners: KNMI, CNRS-IPSL, **MF-CNRM**

Task 3.2.4: *Develop methods to exploit high frequency data from future climate simulations for understanding cloud feedbacks and associated physical processes.*

Partners: **METO**

Task 3.3: Response of boundary-layer clouds to future climate conditions

Experiments with large-eddy simulation models and SCM versions of ESMs under future climate conditions will be performed. In this case future climate conditions will be represented by prescribing different large-scale dynamical conditions at selected locations in the GPCI domain which will be based on results from ESM climate simulations.

Task 3.3.1: *Execution of runs with SCM versions of ESMs for current and idealised future large-scale forcings and LESs for future climate conditions* for shallow cumulus and stratocumulus based on GPCI columns.

Partners: CNRS-IPSL, KNMI, UW, TUD**,** METO, **MPG**

Task 3.3.2: *Quantification of the cloud-climate feedback for the idealised future large-scale forcings.*

Partners: CNRS-IPSL, KNMI, UW, METO, **MPG**

Deliverables (brief description and month of delivery)

D3.1: Description of the set-up for the following cases: ASTEX, the GPCI stratocumulus and shallow cumulus atmospheric columns, and the SCM equilibrium state study (Month 12).

D3.2: Storage in a public archive of instantaneous 3D LES fields and diagnostics from LES fields that are key to parameterization schemes (Month 24).

D3.3: LES and SCM results of the mean state, turbulence structure and microphysics for the ASTEX case and the GPCI stratocumulus and shallow cumulus cases (Month 30).

D3.4: Identification and comparison of the key quantities used in ESM parameterization schemes that control the cloud properties simulated in ESMs with LES results and observations (Month 30).

D3.5: Equilibrium solutions of SCMs, with an emphasis on the equilibrium cloud-top height, cloud liquid water path, cloud fraction, and drizzle rate. Identification of the key quantities that control these quantities (Month 30).

D3.6: Compilation of ESM results at selected grid points (GCPI/CloudNet/ARM/AMMA) (Month 18).

D3.7: A comparison of the hydrological and energy balance and the cloud amount as computed by ESMs with field observations and satellite retrievals at selected locations (Month 36).

D3.8: Report detailing the development and application of methods to exploit high frequency data for understanding cloud feedbacks (Month 36).

D3.9: Quantification of the cloud-climate feedback and its uncertainty for prescribed large-scale conditions in the Hadley circulation regime with aid of results of SCMs (current and future climate) and LES (future climate) (Month 36).

Work package number	WP4	Start date or starting event:		13		
Work package title	Sensitivity Experiments and Hypothesis Testing						
Activity Type[17]	RTD						
Participant number	1	2	3	4	5	6	7
Participant short name	KNMI	MPG	METO	CNRS -IPSL	AA	ECMWF	TUD
Person-months per participant:	26	24	9	10	12	24	6
Participant number	8	10					
Participant short name	MF-CNRM	ETHZ					
Person-months per participant:	4	12					

Objectives

- Develop and test hypotheses proposed to explain inter-model spread in cloud feedback and climate sensitivity in ESMs.

Description of work

In this WP we will integrate results from other work-packages to develop numerical experiments designed to both test our developing understanding and identify observables that can help further constrain cloud feedbacks. The work proposed in this package is broken into three tasks and several subtasks. Each sub-task is identified with a subtask leader.

Task 4.1: Evaluate Unusual Behaviour

In this task we will focus on the development of methods for evaluating the origin and stability of anomalous, or divergent, behaviour among simulations of cloud-feedbacks and climate sensitivity. So doing will narrow our search for observational or other metrics required to narrow our range in uncertainty in cloud feedbacks.

Task 4.1.1: *Compare different NWP-related techniques for identifying biases in cloud representations and sources of anomalous feedback behaviour.*

Partners: **ECMWF**, METO, MPG, KNMI, CNRS-IPSL

Task 4.1.2: *Test the sensitivity of the divergent cloud-feedbacks in models to uncertain parameters*, including vertical resolution. Key findings (for instance the resolution dependence or independence of cloud feedbacks) will be summarised in the form of hypotheses that will then be checked using other climate models in the EUCLIPSE ensemble.

Partners: **MPG**, KNMI, METO, CNRS-IPSL, MF-CNRM

Task 4.2: Developing and Testing Parameterization Improvements

Key parameterization ideas, developed in part on the basis of the evaluation activities in WPs 2 and 3 will be tested in this work-package. Tasks will initially focus on shallow convection and aerosol effects, but may

17 Please indicate <u>one</u> activity per work package:
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expand depending on the outcome of work in WP2 and WP3.

Task 4.2.1: *Evaluate shallow convection cloud-climate feedbacks*, using different representations of shallow convection, across a subset of EUCLIPSE models.

Partners: **KNMI**, TUD, MPG, CNRS-IPSL, METO, ECMWF

Task 4.2.2: *Evaluate cloud-aerosol interactions*, using different representations, across a subset of EUCLIPSE models.

Partners: **ETHZ**, MPG, KNMI

Task 4.3: Establishing Observational Metrics

Given a process level hypothesis about the source of cloud-feedback uncertainty we ask whether there are observational proxies that can measure the effect of such a hypothesis, or are there inferences from the hypothesis that would be observable. In this task we focus on the question: How can one test the ideas we develop using data, rather than just models, the latter being the basis for Task 2. No specific subtasks are identified as they will depend on the outcome of work yet to be completed.

Partners: **MPG**, AA, CNRS-IPSL, METO, KNMI, ECMWF

Deliverables (brief description and month of delivery)

D4.1: A developing database and protocol for parameter and structural (numerical) sensitivity studies by others in the community (Month 24).

D4.2: A study comparing the sensitivity of the models to the numerical structure of the computations (grid and time step) with the parameter sensitivity of the model. This study will also provide best practices for future use of the models, for instance recommendations for integrating diverse physical processes in time and space (Month 36).

D4.3: A study identifying the utility of NWP based methods for identifying and narrowing sources of divergent behavior in cloud-climate feedbacks in models (Month 36).

D4.4: New process representations that can be implemented in models and which will better rationalize (and hopefully narrow) the range of cloud responses by the models (Month 42).

D4.5: A study evaluating the extent to which aerosol-cloud-climate effects depend on the representation of cloud processes (Month 54).

D4.6: Process related metrics that can be used as model development and evaluation tools (Month 42).

D4.7: Revised estimate, with uncertainty bounds, of climate sensitivity from EUCLIPSE ensemble (Month 54).

B.1.3.6 Efforts for the full duration of the project

Project number (acronym) : **Euclipse**

Workpackage[18]		WP0	WP1	WP2	WP3	WP4	TOTAL per Beneficiary
1	KNMI (coord.)	29	6	24	15	26	**100**
2	MPG	0	4	10	10	24	**48**
3	METO	0	9	24	9	9	**51**
4	CNRS-IPSL	0	4	32	10	10	**56**
5	AA	0	24	12	4	12	**52**
6	ECMWF	0	0	0	0	24	**24**
7	TUD	0	0	0	48	6	**54**
8	MF-CNRM	0	10	12	16	4	**42**
9	SU	0	0	24	0	0	**24**
10	ETH	0	0	0	0	12	**12**
11	UW	0	0	0	24	0	**24**
13	DKRZ	0	18	6	0	0	**24**
	Total	29	75	144	136	127	**511**

18 Please indicate in the table the number of person months over the whole duration for the planned work , for each work package by each beneficiary

Template: Project Effort Form 2 - indicative efforts per activity type per beneficiary[19]

Project number (acronym) : EUCLIPSE

Activity Type	1 KNMI	2 MPG	3 METO	4 CNRS-IPSL	5 AA	6 ECMWF	7 TUD	8 MF-CNRM	9 SU	10 ETH	11 UW	13 DKRZ	TOTAL ACTIVITIES
RTD/Innovation activities													
WP1 Evaluation Techniques and Climate model Experiments	6	4	9	4	24	0	0	10	0	0	0	18	75
WP2 Climate Model Evaluation and Analysis	24	10	24	32	12	0	0	12	24	0	0	6	144
WP3 Process Level Evaluation	15	10	9	10	4	0	48	16	0	0	24	0	136
WP4 Sensitivity Experiments and Hypothesis Testing	26	24	9	10	12	24	6	4	0	12	0	0	127
Total 'research'	61	48	51	56	52	24	54	42	24	12	24	24	482
Consortium management activities													
WP0 Management	25	0	0	0	0	0	0	0	0	0	0	0	25
Total ' management'	25	0	0	0	0	0	0	0	0	0	0	0	25
Other activities													
WP0 Management: summerschool organisation	4	0	0	0	0	0	0	0	0	0	0	0	4
Total ' other	4	0	0	0	0	0	0	0	0	0	0	0	4
TOTAL BENEFICIARIES	100	48	51	56	52	24	54	42	24	12	24	24	511

Note: This is a new table, with a breakdown of efforts per beneficiary to activity type level, which was not requested in the proposal

19 Please indicate in the table the number of person months over the whole duration for the planned work , for each work package, for each activity type by each beneficiary

B.1.3.7 List of milestones and planning of reviews

List and schedule of milestones					
Milest. no.	**Milestone name**	**WPs no's.**	**Lead beneficiary**	**Delivery date from Annex I** [20]	***Comments***
M1.1	Completion of COSP and MODIS software and CALIPSO-PARASOL observational products	WP1	**METO**	3	Prototype Models and Observational data sets
M1.2	Completion of the model evaluation packages	WP1	**AA**	18	Prototype Model
M1.3	Delivery of the ESM simulation output	WP1	**DKRZ**	18	Model data
M2.1	Evaluation of cloud-aerosol-radiation interaction achieved	WP2	**MPG**	30	Report
M2.2	Metrics for clouds, precipitation and radiation developed and applied to ESMs and NWP	WP2	**METO**	36	Report
M2.3	Analysis of the link between cloud representation in ESMs and their ability to reproduce intraseasonal and interannual variability (MJO,ENSO) and extreme precipitation over Europe achieved	WP2	**MF-CNRM**	54	Report
M2.4	Analysis of the spread of cloud processes en precipitation of ESM simulations in future climate in ESMs achieved	WP2	**CNRS-IPSL**	54	Report
M3.1	Storage of 3D LES fields and LES diagnostics in a public archive	WP3	**TUD**	24	Model data
M3.2	SCM equilibrium states in the Hadley circulation	WP3	**TUD**	30	Report

[20] Month in which the milestone will be achieved. Month 1 marking the start date of the project, and all delivery dates being relative to this start date.

M3.3	Detailed comparison of LES and SCM results of the stratocumulus to cumulus transition as observed during ASTEX	WP3	**TUD**	30	Model data
M3.4	Identification and comparison of key quantities used in ESM parameterization schemes with LES results and observations	WP3	**KNMI**	30	Report
M3.5	Comparison of the ESMs modelled hydrological and energy balances and cloud amount with observations at selected locations	WP3	**KNMI**	36	Report
M3.6	Quantification of the cloud-climate feedback for idealized large-scale forcing conditions in the Hadley circulation regime	WP3	**MPG**	36	Report
M4.1	Summary of the relative advantages of the Initial Tendency versus Transpose-AMIP techniques for diagnosing systematic biases in climate runs	WP4	**ECMWF**	36	Report
M4.2	Description of experimental protocol for testing hypotheses relating to cloud-climate feedbacks	WP4	**MPG**	30	Report
M4.3	Summary of the relative effects of one- versus two moment microphysical closures on a subset of the EUCLIPSE models on cloud-climate feedbacks for different aerosol concentrations	WP4	**ETHZ**	36	Report
M4.4	Revised estimates of climate sensitivity based on a narrowing in the uncertainty of cloud feedbacks	WP4	**CNRS-IPSL**	54	Report

B.2 Implementation

B.2.1 Management structure and procedures

Because of its modest size, a simple management structure is proposed for EUCLIPSE. It will facilitate the production of deliverables and an efficient flow of funds and information between the partners, administration, the European Commission and the outside world. The management structure builds on proven concepts of other ongoing and successful EU projects. EUCLIPSE will be organised from the Project Coordinator's institute, the Netherlands Royal Meteorological Institute (KNMI). The organisation of the consortium will consist of the Project Coordinator (PC), the Project Assistant Manager (PAM), a Financial Officer, all located at KNMI, the Work Package (WP) leaders, a Management Board (MB) and a Scientific Advisory Board (SAB) and is presented schematically in Figure 2.1 and will be further detailed below.

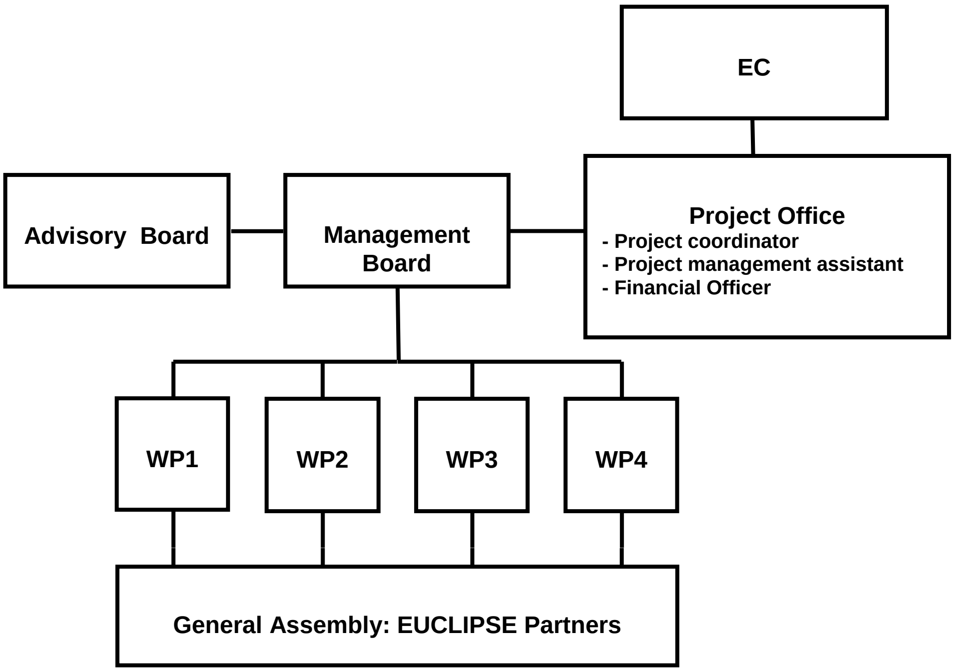

Figure 2.1 Management Structure of EUCLIPSE

The Project Coordinator (A.P. Siebesma, KNMI) of EUCLIPSE leads WP0 (Project Management) and has the overall responsibility for the project. The Project Coordinator oversees and evaluates the progress of the WPs, and reports, stimulates and monitors collaboration between the partners and between the consortium and international organisations, and encourages publications in peer reviewed journals. The Project Coordinator is also responsible for the activities defined in WP0. These include the overall responsibility for the EUCLIPSE web site, the organisation of all the EUCLIPSE meetings, an international workshop on the results of EUCLIPSE, for communication with national and international climate programmes. Furthermore the Project Coordinator is responsible for all the communication between EUCLIPSE and the European Commission, including all forms of reporting to the EC. Finally the Project Officer will chair the Management Board (see below) which will carry out the top level management of the project.

The Project Assistant Manager (located at KNMI) will assist the Project Officer with the internal and external communication of the project. This includes the maintenance of the EUCLIPSE web site, the production of flyers and brochures, the organisation of the annual meetings and the international workshop, the administration and archiving of all reports and communication to the European Commission.

The Financial Officer (located at KNMI) is responsible for the financial administration of the project and the flow of the financial information between the partners and the project office and the provision of necessary documentation to the European Commission. KNMI has an experienced staff in the project administration unit for this task and has extensive experience the coordination with previous and present European Projects.

The Work Package Leaders are responsible for the efficient running and the progress of the respective WPs. They are responsible for the organisation for WP meetings during the annual assembly or extra focussed meetings whenever considered necessary. They also contribute to the top level management of the project through participation in the Management Board (MB).

The Management Board consists of the WP leaders and representatives of all partners and is chaired by the Project Coordinator. The MB will meet during the kick-off meeting and afterwards in principal once a year during the annual general assembly but more frequent meetings are possible if necessary. Furthermore they will be in frequent contact through email and 3-monthly telephone conferences. It will have the responsibility to review the progress in each WP, and decide on success criteria to continue or stop an activity. It is also responsible for the coordination of flow of information and data between the WPs and responsible for cross-cutting themes that involve more than one WP. The MB is also the place to resolve conflicts (see 1.3v for the followed procedures in case of management conflicts). The MB will be in close contact with the Advisory Board and if major choices need to be made, decisions wil be taken following advice from the Advisory Board.

The Advisory Board will add value to EUCLIPSE through commenting on the science plan, on the progress in achieving the plans and will ensure that the project remains directly relevant for the outside world. EUCLIPSE already approached representatives from relevant international agencies and organisations and observational programs (see Section 3.1), and got positive responses from the following representatives to take place in the EUCLIPSE advisory board:

- **Dr. Ghassem R. Asrar**: Director of the World Climate Research Program (WCRP), a Program that oversees various international Projects (e.g. GEWEX, CLIVAR) that have strong overlapping objectives with EUCLIPSE.
- **Prof. Christian Jakob**: Co-chair of the Working Group on Numerical Experimentation (WGNE). WGNE promotes co-ordinated numerical experimentation for validating model results, observed atmospheric properties and exploring the natural and forced variability and predictability of the atmosphere.
- **Prof. Graeme Stephens:** One of the leading scientists working on cloud-related feedbacks in the climate system. He also serves as the principal investigator (PI) of the NASA CloudSat Mission launched in 2006.
- **Prof. Dr. Susanne Crewell**: Expert on state-of the-art of water cycle variables and its application to the evaluation of atmospheric models. She has been active in the FP5 project CloudNet.

These positions will be filled in, in consultation with the European Commission.

The General Assembly will consist of representatives of all institutions presented in section 2.2 "Individual Participants" and any additional contractors entering the project during its life time. They will meet on a annual basis together with the Advisory Board and invited key scientists to present and discuss the progress of the tasks such as defined in the work plan. The General Assembly is the overall platform for direct interaction between all the participants of EUCLIPSE.

B.2.2 Beneficiaries

The sections below will describe the participating institutes, and how the involved key personnel is well equipped to obtain successfully the goals of the project.

Partner 1: (coordinator): Het Koninklijk Nederlands Meteorologisch Instituut (KNMI)

Expertise and experience of the organization

The KNMI (Royal Netherlands Meteorological Institute) is the Dutch national weather service and centre for climate research. Climate research at KNMI is aimed at observing, understanding and predicting changes in the climate system. KNMI produces climate scenarios for use by stakeholders for developing adaptation and mitigation strategies. Climate research is carried out in various divisions: Global Climate Division (global climate change, coupled atmosphere-ocean modeling), Regional Climate Division (boundary layer physics, regional climate modeling), Chemistry and Climate Division, Earth Observation and Climate Division and Climate Advice and Analysis Division.

Role and contribution

KNMI manages the EUCLIPSE project and participates with the Earth System Model EC-EARTH . In WP1 it will perform the long-term global simulations, in WP2 it will contribute to the analysis of the simulations, In WP3 it will coordinate the transpose AMIP experiments and in WP4 it will conduct sensitivity experiments. The atmosphere/land component of EC-EARTH is based on the Integrated Forecast System (IFS) of ECMWF. The ocean component is the NEMO2 model.

Principal personnel involved

Prof. Dr. Pier Siebesma is senior scientist in the Regional Climate Division of KNMI and part-time professor at University of Delft. He is an expert on planetary boundary layer physics and has developed improved convective parameterizations for the ECMWF weather prediction model. Since 2007 he is chair of the GEWEX Cloud Systems Studies (GCSS) and member of the GEWEX Modeling Prediction Panel (GMPP). His main interest is in the understanding, modeling and parameterization of cloud related processes, including cloud physics, cloud dynamics, cloud structures, and moist convection. As such he has been involved in Past Field Campaigns (RICO, BBC), in Large Eddy Simulation (LES) to develop parameterizations for operational ESMs and in the evaluation of the performance of such large scale models.

Dr. Frank M. Selten is scientist in the Global Climate Division of the KNMI. He has a background in large scale atmospheric dynamics and a profound experience in coupled atmosphere-ocean modeling. He has worked on the development of coupled climate models (ECBILT and SPEEDO) and is presently involved in the development of EC-EARTH. His main interest is in the understanding and predictability of large-scale climate variations and change using advanced statistical techniques and concepts from dynamical system theory. He has been involved in conducting and analysing large ensembles of global climate scenario simulations (CHALLENGE and ESSENCE).

Dr. Roel A. J. Neggers is a scientist of the Regional Climate division at the KNMI. As a post-doctoral fellow he has been involved in the FP5 project "EUROCS", in which his main contribution was the organization of the observational data archive that was used in the Pacific Intercomparison study for GCMs. His current research activities concern the development and evaluation of parameterizations for general circulation models. As an ARM fellow he has worked on the development and implementation of an improved boundary layer scheme for the ECMWF NWP model.

Selected relevant publications

Siebesma, A. P., C. S. Bretherton, A. Brown, A. Chlond, J. Cuxart, P. G. Duynkerke, H. Jiang, M. Khairoutdinov, D. Lewellen, C.-H. Moeng, E. Sanchez, B. Stevens, and D. E. Stevens, 2003: A Large-Eddy Simulation intercomparison study of shallow cumulus convection, *J. Atmos. Sci.,* 60, 1201-1219.

Siebesma, A. P., P. M. M. Soares and J. Teixeira, 2007:. A combined Eddy Diffusivity Mass Flux approach for the convective boundary layer. *J . Atmos. Sci*., 64, 1230-1248.

Selten, F.M., G. Branstator, M. Kliphuis and H.A. Dijkstra, 2004: Tropical origins for recent and future Northern Hemisphere climate change. *Geophys. Res. Lett*., 31, L21205, doi:10.1029/2004GL020739.

Neggers, R. A. J., M. Koehler and A. A. M. Beljaars, 2009: A dual mass flux framework for boundary layer convection. Part I: Transport. *J. Atmos. Sci.,* early online release.

Partner 2: Max Planck Society (MPG) – Max Planck Institute for Meteorology (MPI-M)

Expertise and experience of the organization

The **Max Planck Institute for Meteorology** (MPI-M) is dedicated to fundamental climate research. The overall mission of the MPI-M is to understand how physical, chemical, and biological processes, as well as human behaviour, contribute to the dynamics of the Earth system. Among the tools used are advanced numerical models that simulate the dynamics of the atmosphere, the ocean, the cryosphere and the biosphere, and their interactions. MPI-M has developed a comprehensive Earth system model (ESM), centred around the ECHAM. MPI-M is committed to informing decision-makers and the public on questions related to climate change and global change. Finally, the MPI-M is managing the International Max Planck Research School on Earth System Modelling.

Role and contribution

The MPI-M will participate in all work-packages of the project. In WP1 it will contribute to the optimisation of the satellite simulators and perform the long-term global simulations using the ECHAM atmospheric general circulation model, coupled to the MPI-OM and JS-BACH ocean and dynamic vegetation models for the ESM simulations. In WP2 it will contribute to the analysis of the simulations, toward which end the MPI-funded investigator will visit the institute of the WP2 coordinator (S. Bony, CNRS-IPSL). In WP3 it will help define the Atlantic cross section configurations and contribute through simulations with the UCLA LES model. It will also lead WP4 as well as contribute experiments and experimental methodologies

Principal personnel involved

Prof. Dr. Bjorn Stevens is the Director of the MPI-M in the Department “Atmosphere in the Earth System”, and a Professor (on Leave) at the University of California in Los Angeles. He is an expert on atmospheric convection, particularly boundary layer clouds, cloud microphysical and turbulent processes, as well as methodologies for numerically representing such processes. Prof. Stevens has coordinated and lead two international field programs (DYCOMS-II and RICO), coordinated several model intercomparison studies as part of the boundary layer working group of the GEWEX Cloud Systems Studies (GCSS). He is a coordinator of CFMIP (the Cloud Feedback Model Intercomparison Project) and a co-chair of the GEWEX-ILEAPS initiative on aerosol clouds precipitation and climate.

Dr. Johannes Quaas leads an Emmy-Noether Junior Research Group at the MPI-M. Dr. Quaas received his PhD from the Laboratoire de Météorologie Dynamique / IPSL, École Polytechnique, Paris, France in 2003 and continued his career as a post-doc at the Met Office Hadley Centre, Exeter, UK. He is an expert on cloud-aerosol interactions, particularly using observational approaches combining modern satellite retrievals, and is also interested in the analysis of cloud-climate feedbacks through the use of both global climate models and observations. He is a member of CFMIP, of the International Commission of Clouds and Precipitation, and of the editorial boards of “Atmospheric Chemistry and Physics” and “Atmospheric Research”.

Dr. Irina Sandu recently received her PhD in 2008 while working at the CNRM under the supervision of Jean-Louis Brenguier. Dr. Sandu currently holds an Alexander von Humboldt Fellowship. She used large-eddy simulation to study how the diurnal cycle modulates cloud-aerosol interactions in marine stratocumulus.

Selected relevant publications

Medeiros, B., **B. Stevens**, I. M. Held, M. Zhao, D. L. Williamson, J. G. Olson and C. S. Bretherton, 2008: Aquaplanets, climate sensitivity, and low clouds. *J. Climate*, 21, 4974-4991.

Quaas, J., O. Boucher, N. Bellouin, and S. Kinne, 2008: Satellite-based estimate of the direct and indirect aerosol climate forcing, *J. Geophys. Res*., 113, D05204, doi:10.1029/2007JD008962.

Sandu, I., J. L. Brenguier, O. Geoffroy, O. Thouron, and V. Masson, 2008: Aerosol impacts on the diurnal cycle of marine stratocumulus. *J. Atmos. Sci*., 65, 2705–2718.

Stevens, B., 2007: On the growth of layers of non-precipitating cumulus convection. *J. Atmos. Sci*., 64, 2916-2931.

Partner 3: UK Met Office (METO)

Expertise and experience of the organization

The Met Office Hadley Centre (MOHC) is the climate research division of the UK's national meteorological service. Its aims are to: understand physical, chemical and biological processes within the climate system and develop computer models of the climate which represent them; use computer models to simulate the differences between global and regional climates, the changes seen over the last 100 years, and to predict changes over the next 100 years; monitor global and national climate variability and change; attribute recent changes in climate to specific factors.

The MOHC has a strong track record of research into understanding and evaluating cloud feedbacks in climate models and is taking a leading role in the coordination of the Cloud Feedback Model Intercomparison Project (CFMIP). Hadley Centre work on cloud feedbacks was heavily cited in Fourth IPCC assessment report. The MOHC has taken part in a number of successful EU funded projects relevant to the cloud feedback problem, including EC-Clouds (FP4) and ENSEMBLES (FP6-coordinated by the MOHC). The MOHC is at the forefront of process based evaluation of cloud in models, for example being one of the first modelling centres to apply cloud compositing evaluation techniques to climate models.

Role and contribution

The Met Office will contribute to work packages WP1, WP2, WP3, and WP4.

Principal personnel involved

Mark Webb leads the Cloud Feedback Model Intercomparison Project and performs personal research on understanding cloud feedback mechanisms in climate models. He has 18 years experience working on evaluation and understanding of cloud and water vapour feedbacks in climate models. He co-developed the ISCCP simulator and has participated in the EC-CLOUDS and ENSEMBLES EU projects. He was a contributing author of the 4th IPCC assessment WG1 report.

Mark Ringer leads the Climate Sensitivity group at the Met Office Hadley Centre. His main research interests are the role of clouds in the climate system, including cloud feedback effects under climate change, and the use of satellite data for studying the climate and for evaluating and improving climate models.

Alejandro Bodas-Salcedo is the lead developer and co-ordinator of the CFMIP Observational Simulator Package (COSP) which is to be used in forthcoming model intercomparison projects to facilitate the evaluation of models using CloudSat and CALIPSO data.

Selected relevant publications

Bodas-Salcedo, et al., 2008: Evaluating cloud systems in the Met Office global forecast model using simulated CloudSat radar reflectivities. *J. Geophys. Res.*, 113**,** D00A13, doi:10.1029/2007JD009620

Ringer, M.A. et al., 2006: Global mean cloud feedbacks in idealized climate change experiments. *Geophys. Res. Lett.*, 33(7), L07718.

Partner 4: Centre National de la Recherche Scientifique, Institut Pierre Simon Laplace (CNRS-IPSL)

Expertise and experience of the organization

CNRS-IPSL (Institut Pierre Simon Laplace) is a federation of six research laboratories in the Paris area. The main laboratories involved in EUCLIPSE are LMD and LOCEAN. The objectives of this federation are three-fold: fundamental research in sciences of the global environment and planetology, observations of the Earth System, together with education in Earth System sciences. Research activities focus on process studies and on modelling of coupled ocean-atmosphere-biosphere-cryosphere systems. CNRS-IPSL acts as a leading institution in climate research, has co-coordinators or members of steering committees and main international climate programmes, and contributed to European and international scientific assessments. CNRS-IPSL has been involved in many European projects such as. ENSEMBLES or METAFOR.

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Role and contribution

CNRS-IPSL will lead the work-package WP2 and will contribute to work-packages WP1, WP3 and WP4.

Principal personnel involved

Dr. Sandrine Bony is a CNRS researcher at CNRS-IPSL since 1996, worked at the Massachusetts Institute of Technology (MIT, USA) from 1999 to 2001, and has more than 15 years of research experience. Her research focuses on the role of clouds and moisture in climate (tropical variability and climate sensitivity), on the parameterization of cloud and convective processes in large-scale models, on the use of satellite observations to evaluate climate models, and on the analysis and model inter-comparison of climate change cloud feedbacks. She was a lead author of the 4th assessment report of the IPCC WG1, responsible for the section on climate sensitivity and feedbacks. She co-coordinates the Cloud Feedback Model Intercomparison Project (CFMIP), has been an editor of the Journal of Climate from 2005 to 2008, is a member since 2006 of the WCRP JSC/CLIVAR Working Group on Coupled Models (WGCM) and has become co-chair of WGCM in 2008.

Dr. Hélène Chepfer is an Assistant Professor of University Pierre et Marie Curie (Paris) at CNRS-IPSL. She is a specialist of cloud optical and radiative properties, and an expert in the use of passive and active remote sensing observations to characterize cloud properties and to evaluate clouds in regional and in climate models. She contributed to intensive field experiments (EUCREX, CRYSTAL-Face), to the SIRTA ground-based observatory, and to several space borne missions (POLDER/PARASOL, MODIS, CERES, CALIPSO). She is a key contributor to the development of the CFMIP Observations Simulator Package (COSP), and at the origin of the GOCCP (GCM-Oriented CALIPSO Cloud Product) dataset consistent with the CALIPSO simulator outputs of COSP.

Dr. Frédérique Chéruy is a CNRS researcher at LMD/IPSL. She has an expertise in the analysis of satellite data and radiative transfer. She has been involved in the improvement of the convective parameterization of the IPSL ESM. She is presently involved in the evaluation of the representation of clouds simulated by the LMD GCM (the atmospheric component of the IPSL ESM) with particular focus on the Europe/Mediterranean area as well as on the boundary layer clouds. In this framework, she develops process oriented diagnostics in the nudged version of the LMDZ GCM, at regional scale and at the scale of the SIRTA instrumented site maintained by IPSL at Palaiseau. She is leading scientist for the LMD in the FP6-2004-RTN MODOBS ("Atmospheric modelling for wind energy, climate and environ mental applications, exploring added value from new observation techniques").

Dr. Jean-Louis Dufresne is a CNRS researcher at LMD/IPSL, and currently leads the IPSL "Global Climate Modeling Group". He has 20 years research experience in the field of climate modeling. He is involved in the development of the LMDZ atmospheric model, he is central in the development of the IPSL Coupled Model and in the achievement of climate change simulations in various project (CMIP, IPCC AR4, ENSEMBLES...). During the last 10 years, his main research has mainly focused on: model coupling, global climate and climate change studies, cloud feedbacks, climate-carbon cycle feedback and radiative transfer computations. He is the coordinator of ENSEMBLES-RT4

("Understanding the processes governing climate variability and change, climate predictability and the probability of extreme events") and a member of the international CALIPSO science team.

Dr. Eric Guilyardi is a CNRS researcher at LOCEAN/IPSLand has over 12 years of experience in tropical climate variability, climate change and multi-model analysis. He has contributed as expert reviewer to the recent IPCC AR4 and is principal investigator or co-investigator of a number of EU projects, including FP5 (SINTEX, PRISM), FP6 (DYNAMITE, ENSEMBLES) and FP7 (METAFOR coordinator, http://metaforclimate.eu). He is leading the ENSO metrics work group within the Pacific Panel of CLIVAR. He also holds a joint appointment with the University of Reading, in the UK.

Dr. Frédéric Hourdin is a CNRS researcher at LMD/IPSL. He is an expert of atmospheric modeling, with a particular interest on the parameterization of boundary-layer processes, atmospheric transport and planetary atmospheres. He is responsible for the LMDZ GCM development (the atmospheric component of the IPSL ESM), and coordinator of the AMMA-Model Intercomparison Project.

Selected relevant publications

Bony, S., R. Colman, V. M. Kattsov, R. P. Allan, C. S. Bretherton, J.-L. Dufresne, A. Hall, S. Hallegatte, M. M. Holland, W. Ingram, D. A. Randall, B. J. Soden, G. Tselioudis and M. J. Webb, 2006: How well do we understand and evaluate climate change feedback processes? *J. Climate,19 (15), 3445-3482.*

Bony, S and **J.-L. Dufresne**, 2005; Marine boundary layer clouds at the heart of tropical cloud feedback uncertainties in climate models, *Geophys. Res. Lett.*, 32, No. 20, L20806, doi:10.1029/2005GL023851.

Chepfer, H., **S. Bony**, D. Winker, M. Chiriaco**, J.-L. Dufresne** and G. Sèze, 2008: Use of CALIPSO lidar observations to evaluate the cloudiness simulated by a climate model. *Geophys. Res. Lett.*, 35, L15704, doi:10.1029/2008GL034207.

Dufresne, J.-L., and **S. Bony**, 2008: An assessment of the primary sources of spread of global warming estimates from coupled ocean-atmosphere models. *J. Climate*, 21 (19), 5135-5144.

Guilyardi, E., 2006: El Niño- mean state - seasonal cycle interactions in a multi-model ensemble. *Clim. Dyn.,* **26**:329-348, DOI: 10.1007/s00382-005-0084-6

Hourdin, F., I. Musat, **S. Bony**, P. Braconnot, F. Codron, **J.-L. Dufresne**, L. Fairhead, M.-A. Filiberti, P. Friedlingstein, J.-Y. Grandpeix, G. Krinner, P. LeVan, Z.-X. Li, and F. Lott, 2006: The LMDZ general circulation model: climate performance and sensitivity to parameterized physics with emphasis on tropical convection. *Clim. Dyn.*, 19 (15), 3445-3482.

Randall, D. A., R. A. Wood, **S. Bony**, R. Colman, T. Fichefet, J. Fyfe, V. Kattsov, A. Pitman, J. Shukla, J. Srinivasan, R. J. Stouffer, A. Sumi and K. E. Taylor, 2007: Climate Models and Their Evaluation. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Partner 5: Academy of Athens (AA)

Expertise and experience of the organization

The Research Centre for Atmospheric Physics and Climatology of the Academy of Athens is addressing both global and regional climate changes in different space and time scales. The Centre is collaborating with international Research Institutions (NASA/GISS, Max Planck Institute for Meteorology) as well as other Universities and Institutions in Greece. The Centre focuses on climate processes through both observational analyses from satellite and surface platforms and climate modelling studies. In particular, the Centre is developing a strategy to expand its activities in studies of the global water and energy cycles, the carbon cycle, and the ocean circulation, with the objective to understand the operation of the main physical processes and to predict their change with climate warming. The Centre will be involved in studies not only of future but also of past and present climate variability, trends and extreme events on time scales from years to centuries. The Centre is a member of the European Network on Earth System Modeling (ENES) and of the COSMOS consortium, and leads the Model Evaluation Work Package in the recently approved FP7 proposal entitled 'Infrastructure for the European Network on Earth System Modeling, IS-ENES'. Finally, Centre affiliated scientists have long been working in studies of changes in cloud properties and climate changes resulting from cloud-climate interactions.

Role and contribution

Leader of WP1 on the Infrastructure for Process Based Model Evaluation and participates in WP2, WP3 and WP4.

Principal personnel involved

Dr. George Tselioudis has done extensive work on issues related to cloud, radiation and precipitation changes with climate change, using both satellite and ground based observations and climate model simulations. He has been involved in model evaluation projects and is the co-creator of the GEWEX Cloud System Study Data Integration for Model Evaluation (GCSS-DIME) web site.

Dr. Anastasia Romanou has extensive experience in developing and running global coupled models and has used satellite and in-situ observations to evaluate climate model output.

Selected relevant publications

Williams, K. D., and **G. Tselioudis**, 2007: GCM intercomparison of global cloud regimes: Present-day evaluation and climate change response. *Clim. Dyn.*, 29, 231-250, doi:10.1007/s00382-007-0232-2.

Tselioudis, G., W. B. Rossow, A. N. Gentilcore, and J. Katzfey, 2004: The Data Integration for Model Evaluation web site: A one-stop shop for model evaluation. *Bull. Am. Met. Soc.*, 85, 830-835, doi:10.1175/BAMS-85-6-830.

Tselioudis, G., and C. Jakob, 2002: Evaluation of midlatitude cloud properties in a weather and a climate model: Dependence on dynamic regime and spatial resolution. *J. Geophys. Res.*, 107, no. D24, 4781, doi:10.1029/2002JD002259.

Romanou, A., B. Liepert, G. A. Schmidt, W. B. Rossow, R. A. Ruedy, and Y.-C. Zhang, 2007: 20th Century changes in surface solar irradiance in simulations and observations. *Geophys. Res. Lett.*, 34, L05713, doi:10.1029/2006GL028356.

Partner 6: European Centre for Medium-Range Weather Forecast (ECMWF)

Expertise and experience of the organization

ECMWF has been a leading operational centre for global medium-range weather forecasts since the 1970s. It has pioneered developments in numerical modelling of weather, both in terms of numerics and sub-grid parameterisation. As part of its forecast verification capability, ECMWF has developed a range of sophisticated diagnostic tools, including initial tendency diagnostics, which are used to pinpoint errors in the numerical representation of specific processes in the momentum or thermodynamic equations.

Since the mid 1990s, ECWMF has developed a seasonal forecast capability by coupling its atmospheric model to a state of the art ocean model, and developing an ocean analysis system. ECMWF played a coordinating role in the development of multi-model ensemble forecast methods for seasonal to interannual prediction. More recently, through the FP7 project ENSEMBLES, ECWMF has begun to explore atmospheric predictability on the decadal timescale.

ECMWF has pioneered a number of developments in atmospheric science including the use of ensemble forecasts for probabilistic prediction, four dimensional variational data assimilation to determine forecast initial conditions as accurately as possible, and reanalysis as a tool for climate diagnosis. Recently, ECMWF has been at the forefront of developing seamless prediction techniques and of exploring their potential for unifying weather and climate prediction.

Role and contribution

ECMWF will contribute to WP4.

Principal personnel involved

Dr. Tim Palmer is Head of the Probability Forecast Division, coordinator of EU PROVOST and DEMETER projects, the latter winning the WMO Gerbier-Mumm award, and co-chair of the WCRP CLIVAR International Science Steering Group. He has pioneered the development of seamless prediction techniques in collaboration with his ECMWF colleagues below.

Dr. Mark Rodwell got his PhD in 1993 on the dynamics of the Indian monsoon. Since then, he has worked at the Reading University Department of Meteorology (primarily on Monsoon and Desert related topics), the UK Met Office Hadley Centre (on the North Atlantic Oscillation including work on the European project PREDICATE), and at the European Centre for Medium-range Weather Forecasts, ECMWF (on diagnostics of the global circulation, predictability and seamless approaches to weather and climate forecasting).

Dr. Antje Weisheimer has experience in the evaluation of climate models on seasonal, decadal and centennial time scales. She works in the ECMWF seasonal forecast group under the EU FP6 ENSEMBLES project on ensemble-based methodologies to model uncertainty. Recently she has been involved in developing a novel approach to the concept of seamless weather and climate prediction by combining regional multi-model climate change projections with reliability information from verified short-range predictions.

Selected relevant publications

Rodwell, M. J., and **T. N. Palmer**, 2007: Using numerical weather prediction to assess climate models. *Quart. J. Roy. Meteor. Soc*., **133**, 129-146.

Partner 7: Delft University of Technology (TUD)

Expertise and experience of the organization

The new research theme “Clouds, Climate and Air Quality” at the Department of Multi-Scale Physics has just been established in 2006. The three staff members, however, have a long track record in cloud research. The main objective is to perform fundamental research on cloud dynamics and cloud microphysics to improve parameterizations in weather and climate models. A wide variety of research tools are used, ranging from detailed numerical simulation, laboratory experiments, field campaigns, and analysis of aircraft data and satellite observations.

Role and contribution

TUD is leader of WP 3. In particular it will lead the task 3.1 on the LES and SCM evaluations on specific key locations dominated by boundary layer clouds.

Principal personnel involved

Dr. Stephan de Roode is Assistant Professor at TU Delft. He obtained his PhD (1999) at the Institute for Marine and Atmospheric Research Utrecht (IMAU), Utrecht University, on the basis of a study on the aircraft observations of cloud-topped boundary layers and mass-flux parameterizations. He has worked at the Royal Dutch Meteorological Office (KNMI), the University of Washington (Seattle, WA, USA), and the Naval Postgraduate School in Monterey (CA, USA) where he studied aircraft observations and large-eddy simulation results of boundary layer clouds to improve parameterizations schemes used in ESMs. He took part in the Surface Heat and Energy Balance of the Arctic Ocean (SHEBA) experiment and the Baltex BRIDGE measurement Campaign (BBC). He was co-leader of the EUROCS working group on the diurnal cycle of stratocumulus. For more than 10 years he is an active member of the GEWEX Cloud System Studies Working Group 1.

Dr. Harm Jonker is Associate Professor at TU Delft. He got his PhD in Physics at Utrecht University in 1993 and held post-doc positions at the Royal Dutch Meteorological Office (KNMI) and the Institute for Marine and Atmospheric Research Utrecht (IMAU), during which he worked on large eddy simulations of cloudy boundary layers in conjunction with satellite observations. In 2000 he was tenured at Delft University where he expanded his cloud research by including observational studies, and by including laboratory experiments as well as direct numerical simulations to study detailed cloud microphysical processes; he also integrated a virtual reality environment to study the intricate dynamics at cloud-edges and to analyse the statistics of cloud life-cycles. In the department of Multi-Scale Physics he initiated the new research theme 'Clouds, Climate and Air Quality', which he is heading since 2006. Jonker is a regular visiting scientist at the National Center for Atmospheric Research (Boulder, CO).

Selected relevant publications

De Roode, S. R. and P. G. Duynkerke, 1997: Observed Lagrangian transition of stratocumulus into cumulus during ASTEX: Mean state and turbulence structure. *J. Atmos. Sci*., 54, 2157-2173.

De Roode, S. R., P. G. Duynkerke and **H. J. J. Jonker, 2004**: Large Eddy Simulation: How large is large enough? *J. Atmos. Sci*., 61, 403-421.

Duynkerke, P. G., **S. R. de Roode**, M. C. van Zanten, J. Calvo, J. Cuxart, S. Cheinet, A. Chlond, H. Grenier, P. J. Jonker, M. Koehler, G. Lenderink, D. Lewellen, C.-L. Lappen, A. P. Lock, C.-H. Moeng, F. Müller, D. Olmeda, J.-M. Piriou, E. Sanchez, I. Sednev, 2004: Observations and numerical simulations of the diurnal cycle of the EUROCS stratocumulus case. *Quart. J. Roy. Meteor. Soc*., 130, 3269-3296.

Jonker, H.J.J. , P.G. Duynkerke and J.W.M. Cuijpers, 1999: Mesoscale fluctuations in scalars generated by boundary layer convection., 1999. *J. Atmos. Sci*., 56, 801-811.

Jonker, H. J. J., T. Heus and P. P. Sullivan, 2008: A refined view of vertical mass transport by cumulus convection. *Geophys. Res. Lett.*, 35, L07810, doi:10.1029/2007GL032606.

Partner 8: Météo-France - Centre National de Recherches Météorologiques (MF-CNRM)

Expertise and experience of the organization

Météo-France**,** the French weather service, is represented in EUCLIPSE by its research centre, the « Centre National de Recherches Météorologiques **»** (CNRM), which is responsible for conducting meteorological and climatological research activities, and for coordinating research/development undertakings conducted within other departments. To carry out its missions, CNRM hosts approximately 275 permanent positions and 70 students and visitors, working in specialised divisions. The climate group « GMGEC » is one of these divisions in charge of the studies of natural climate variability and of the impact of human activities on climate. The main focus is on the development of climate models, the study of ocean-atmosphere and land-atmosphere interactions, the understanding of climate variability and predictability, the long-range forecasting of seasonal climate anomalies, the projection of climate change at global and regional scales, as well as the study of atmospheric chemistry and its interaction with climate.

Role and contribution

CNRM will implement the COSP simulator and contribute to the coordinated experiments in WP1, evaluate the aquaplanet and AMIP simulations with a focus on ITCZ climatology, tropical intra-seasonal variability and extreme temperatures over Europe in WP2, contribute to SCM and transpose-AMIP experiments and evaluate these simulations over West Africa in WP3, contribute to the coordinated sensitivity experiments related to the structural uncertainty of climate models in WP4.

Principal personnel involved

Isabelle Beau has an engineering degree in meteorology, a PhD in atmospheric science. She has been working at CNRM and ENM since 1992 in the field of evaluation of physical parameterizations for climate and NWP models, using SCM, CRM/LAM and GCM tools.

Gilles Bellon joined the CNRM-GAME in 2008. His work focuses on the natural variability of the tropical climate and on its sensitivity to global change. In particular, his work addresses the mechanisms at play in the dynamics of the tropical convergence zones and the problems of their simulation by GCMs.

Dominique Bouniol joined the CNRM-GAME in 2002. Her main research focus is in cloud microphysics and mesoscale processes. She is working in the AMMA project in order to understand the impact of ice anvil clouds in the west african monsoon system. She is part of the CALIPSO/CloudSat science team.

François Bouyssel has been working at CNRM since 1998. He has been head of the research group in charge of improving the representation of physical processes in operational NWP applications (models and assimilations) since 2001.

Michel Déqué has been working at the research Centre of Météo-France since 1979. He has been head of the research group developing the climate version of ARPEGE-IFS for more than 15 years.

Hervé Douville has been working at CNRM since 1995 in the field of global climate modelling and the study of the global water cycle variability. He is coordinating the French ANR IRCAAM project aimed at a better understanding of tropical climate variability and related teleconnections.

Françoise Guichard joined the CNRM-GAME in 2001. Her main research focus is on fine scale modeling of boundary layer and moist convection. She has been involved in EUROCS, ARM and AMMA, a European project where she has been in charge of coordinated a case study.

Selected relevant publications

Bellon, G., and A. Sobel, 2008: Instability of the axisymmetric monsoon flow and intraseasonal oscillation. *J. of Geophys. Res.*, 113, D07108, doi:10.1029/2007JD009291.

Bouniol, D., A. Protat, A. Plana-Fattori, M. Giraud, J.-P. Vinson and N. Grand, 2008: Comparison of airborne and spaceborne 95 GHz radar reflectivity and evaluation of multiple scattering effect in spaceborne measurements. *J. Atmos. Oceanic Technol.*, 25, 1983-1995.

Déqué, M., D. P. Rowell, D. Lüthi, F. Giorgi, J. H. Christensen, B. Rockel, D. Jacob, E. Kjellström, M. Castro, B. van den Hurk, 2007: An intercomparison of regional climate simulations for Europe: assessing uncertainties in model projections. *Climatic Change*, 81, 53-70.

Douville H., D. Salas-Mélia, and S. Tyteca, 2006: On the tropical origin of uncertainties in the global land precipitation response to global warming. *Clim. Dyn.*, 26, 367-385, doi:10.1007/s00382-005-0088-2.

Guichard, F., D. Parsons, J. Dudhia, and J. Bresh, 2003: Evaluating mesoscale model predictions and parameterisations against SGP ARM data on a seasonal time scale. *Mon. Wea. Rev*., 131, 926-944.

Partner 9: Stockholm University (SU)

Expertise and experience of the organization

The Department of Meteorology, Stockholm University, (MISU) has a strong atmospheric numerical modeling tradition that goes back to the days when C-G Rossby was the professor and conducted the very first operational numerical weather forecasts in the 1950's. Today we employ research in regional modeling both for forecasting and dynamic downscaling at all scales, with a special expertise in model physics (parameterizations) concerning boundary-layer and mesoscale dynamics and clouds. We also participate in the development of the CCSM global community climate model and in EC-Earth. MISU also has a strong tradition in Arctic meteorology since 1991, responsible for four major atmospheric expeditions to the central Arctic basin on the Swedish icebreaker Oden; the latest (Arctic Summer Cloud-Ocean Study, ASCOS) in summer of 2008 was the largest single atmospheric Arctic experiment during the International Polar Year (IPY) and was coordinated by two MISU professors. In the last decade we have also built up an expertise in regional climate modeling for the Arctic to complement the experimental work. MISU today employs about 70 in total, of which about 10 is permanent faculty, 5-10 are temporary research staff (junior researcher, assistant professors or post doc etc.) and 25 graduate students; the rest is technical and administrative support staff.

Role and contribution

SU will participate in WP2 on the evaluation of Arctic clouds with Cloudsat and CALIPSO.

Principal personnel involved

Dr. Gunilla Svensson's expertise is in numerical modelling from process scale to global scale. The focus of the modelling work is on boundary layer processes, surface exchange and clouds. She is currently involved in developing the next generation of the atmospheric part of CCSM. She is co-charing the GEWEX Atmospheric Boundary Layer Study and has been involved in a number of model validation studies.

Dr. Michael Tjernström's expertise is in combining observational studies with numerical modelling and has an extensive experience of both. Since early 2000 his focus has been the Arctic climate and he has been coordinating two Arctic expeditions. He is also one of the leading participants in ARCMIP.

Selected relevant publications

Graversen, R.G., T. Mauritsen, **M. Tjernström**, E. Källen and **G. Svensson**, 2008: Vertical structure of recent Arctic warming, *Nature*, 541, doi:10.1038 /nature06502.

Karlsson, J., **G. Svensson** and H. Rodhe, 2008: Cloud Radiative Forcing of subtropical low level clouds in global models. *Climate Dynamics,* doi:10.1007/s00382-007-0322-1.

Karlsson, J. and **G. Svensson**, 2008: The simulation of Arctic clouds and their radiative properties for present-day climate in the CMIP3 multi-model dataset. *Manuscript in preparation.*

Tjernström, M., M. Žagar, **G Svensson**, J Cassano, S. Pfeifer, A. Rinke, K. Wyser, K. Dethloff, C. Jones and T. Semmler, 2005: Modeling the Arctic Boundary Layer: An evaluation of six ARCMIP regional-scale models with data from the SHEBA project. *Bound.-Lay. Meteor.*, 117, 337 - 381.

Tjernström, M., J. Sedlar and M. Shupe, 2007: How well do regional climate models reproduce radiation and clouds in the Arctic? An evaluation of ARCMIP simulations. *J. of App. Meteor. and Clim*., 47, 2405-2422.

Partner 10: Eidgenössische Technische Hochschule Zürich (ETHZ)

Expertise and experience of the organization

The Institute for Atmospheric and Climate Science (IACETH) at ETH Zurich is part of the Department of Environmental Sciences (D-UWIS). IACETH straddles the inter-related disciplines of atmospheric and climate science. It pursues leading-edge research on atmospheric physics, chemistry and dynamics, and on global and regional past, present and future climate, and it pioneers activities at the interfaces of these sub- component fields and the interfaces to other disciplines. IACETH has 110 members and consists of seven research groups. The Atmospheric Physics group, led by Prof. Lohmann, focuses on aerosol-cloud interactions in warm, mixed phase and ice clouds and their importance for the radiation budget and the hydrological cycle. It develops instrumentation and observation methods, applying these to aerosol and cloud microphysics in field experiments and in the laboratory. It maintains a suite of numerical models ranging from cloud- resolving models over regional weather prediction models to global climate models.

Role and contribution

ETHZ will contribute in WP4 by evaluating of cloud-aerosol-radiation interactions in ESMs and through sensitivity ESM experiments.

Principal personnel involved

Prof. Ulrike Lohmann has published more than 120 peer-reviewed articles. She works or has worked in several international committees, among them as a lead author for the Fourth Assessment Report of the Intergovernmental Panel for Climate Change (IPCC) and as a member of the scientific steering committees of ICCP, IGAC and the GEWEX Cloud System Studies (GCSS) Panel. She is editor for the magazine "Atmospheric Chemistry and Physics". Prof. Lohmann was awarded the AMS Henry G. Houghton Award (2007) “For pioneering contributions to the representation and quantification of the effects of cloud-aerosol interactions on climate.” She became a “fellow” of the American Geophysical Union in 2008.

Selected relevant publications

Hoose, C., **U. Lohmann**, R. Bennartz, B. Croft and G. Lesins, 2008: Global simulations of aerosol processing in clouds, *Atmos. Chem. Phys*. 8, 6939-6963.

Hoose, C., **U. Lohmann**, B. Verheggen, E. Weingartner and P. Stier, 2008: Aerosol Processing in Mixed-Phase Clouds in ECHAM5-HAM: Model Description and Comparison to Observations. *J. Geophys. Res.*, 113, doi:10.1029/2008JD009954.

Lohmann, U, 2008: Global anthropogenic aerosol effects on convective clouds in ECHAM5-HAM. *Atmos. Chem. Phys.*, 8, 2115-2131.

Lohmann, U., P. Spichtinger, S. Jess, T. Peter, and H. Smit, Cirrus cloud formation and ice supersaturated regions in a global climate model, *Env. Res. Lett.*, 3, 045022, 2008.

Lohmann, U., P. Stier, C. Hoose, S. Ferrachat, S. Kloster, E. Roeckner and J. Zhang, 2007: Cloud microphysics and aerosol indirect effects in the global climate model ECHAM5-HAM. *Atmos. Chem. Phys.*, 7, 3425-3446.

Lohmann, U. and K. Diehl, 2006: Sensitivity studies of the importance of dust ice nuclei for the indirect aerosol effect on stratiform mixed-phase clouds. *J. Atmos. Sci*. 63, 968-982.

Stier, P., J. Feichter, S., Kinne, S. Kloster, E. Vignati, J. Wilson, L. Ganzeveld, I, Tegen, M. Werner, M. Schulz, Y. Balkanski, O. Boucher, A. Minikin, and A. Petzold, 2005: The Aerosol-Climate Model ECHAM5-HAM. *Atmos. Chem. Phys*, 5, 1125-1156.

Storelvmo, T., **U. Lohmann** and R. Bennartz, 2009: What governs the spread in shortwave forcings in the transient IPCC AR4 models? *Geophys. Res. Lett*., 36, in press.

Storelvmo, T., J.-E. Kristjansson and **U. Lohmann**, 2008: Aerosol influence on mixed-phase clouds in CAM-Oslo, *J. Atmos. Sci*., 65, 3214-3230.

Partner 11: University Of Warsaw (UW)

Expertise and experience of the organization

Institute of Geophysics (IGFUW) is a research and academic unit in the Faculty of Physics at the University of Warsaw. The main scientific areas developed in the Institute are: cloud microphysics including experimental studies, cloud modelling, and aerosol radiative properties. Institute of Geophysics is collaborating with many international research institutions (Meteo-France, NCAR, Max Planck Institute for Meteorology, KNMI). In the field of cloud modelling IGFUW is collaborating with NCAR and uses EULAG model (EUlerian – LAGrangian numerical solver for all-scale geophysical flows) in the LES version is used to study physical processes involved in the aerosol indirect effect. Of main interest are entrainment and mixing processes. We were involved in intercomparison studies of BOMEX and RICO experiments. Data analysis of microphysical cloud parameters collected during international field experiments (ACE-2, DYCOMS-II, RICO, EUCAARI-Impact) is used to develop parameterizations, validate model and perform process studies. IGF was a partner in 2 FP5 (PACE, CESSAR), 2 FP6 (QUANTIFY, EUCAARI) and 2 FP7 (COPAL, EUFAR) projects.

Role and contribution

University of Warsaw will contribute to the LES experiments and evaluations for present and future climate such as described in Tasks 3.1 and 3.3 of WP3

Principal personnel involved

Dr. Hanna Pawlowska is professor in the Institute of Geophysics at the University of Warsaw. She has got her Ph. D. in 1991 and habilitation in 2000. In 1993-1998 she worked at the Centre National de Recherches Meteorologiques in Toulouse (France) as visiting scientist, and in 1999-2000 at the Laboratoire de Meteorologie Dynamique in Paris. Her research interests include cloud microphysics and interaction with radiation. She collaborates closely with Dr. W. Grabowski from NCAR in the field of cloud modeling, supervising conjointly 2 PhD students. Her biggest scientific expertise is in experimental data analysis and its used to the model validations and construction of parameterizations. She was PI inFP5, FP6 and FP7 (construction of European research infrastructure COPAL).
Hanna Pawlowska teaches graduate level atmospheric courses at the Faculty of Physics, Warsaw University. She is currently advises three Ph.D. candidates. She has authored 20 peer-reviewed articles. She is a member of the Scientific Advisory Board at the Max-Planck Institute for Meteorology, and executive board of the International Conference on Clouds and Precipitation.

Selected relevant publications

Slawinska, J., W. W. Grabowski, **H. Pawlowska**, and A. A. Wyszogrodzki, 2008: Optical properties of shallow convective clouds diagnosed from a bulk-microphysics Large Eddy Simulation. *J. Climate*, 21, 1639-1647.

Pawlowska, H., W. W. Grabowski, and J. L. Brenguier, 2006: Observations of the width of cloud droplet spectra in stratocumulus. *Geophys. Res. Lett.*, **33**, L19810, doi:10.1029/2006GL02841.

Pawlowska, H., and J. L. Brenguier, 2003: An observational study of drizzle formation in stratocumulus clouds for general circulation model (GCM) parameterization. *J. Geophys. Res.-Atmos.*, 108 (D15)**,** 8630, doi:10.1029/2002JD002679.

Pawlowska, H., and J. L. Brenguier, 2000: Microphysical properties of stratocumulus clouds during ACE2. *Tellus*, 52B, 867-886.

Brenguier, J. L., **H. Pawlowska**, L. Schueller, R. Preusker, J. Fischer, and Y. Fouquart, 2000: Radiative properties of boundary Layer clouds: optical thickness and effective radius versus geometrical thickness and droplet concentration. *J. Atmos. Sci.*, 57, 803-821.

Partner 13: German Climate Computation Center (DKRZ)

Expertise and experience of the organization

The German Climate Computational Center (DKRZ**)** is a national German facility, providing state-of-the-art super-computing data service and other associated services to the German and also the international scientific community to conduct top of the line Earth System and Climate Modelling. DKRZ operates a fully scalable supercomputing system designed for and dedicated to earth system modelling. DKRZ is currently replacing its high performance computing system with a new 7640 core IBM Power6 supercomputer with a peak performance of 140 TeraFlops and will upgrade its mass storage system to a capacity of at least 60 PetaByte. Associated services provided by DKRZ include general user support as well as specific support in scientific computing. DKRZ plays an active role within the German e-science initiative and is a leading partner within the Collaborative Climate Community Data and Processing Grid (C3-Grid, see also http://www.c3grid.de/) as well as the FP7 project IS-ENES (Infrastructure for the European Network for Earth System Modelling"). Together with the Model and Data group - which will be integrated into DKRZ in 2010 - DKRZ operates the ICSU World Data Centre for Climate (**WDCC**) which archives and disseminates more than 340 TB climate model data and related observations. All WDCC data are accessible by a standard web-interface (cera.wdcc-climate.de). WDCC/DKRZ acts as one of the three data nodes for the next IPCC assessment report. The data management for CMIP5/IPCC-AR5 will be shared between BADC (UK), PCMDI (US) and WDCC/DKRZ.

Role and contribution

WDCC/DKRZ will participate in EUCLPISE with respect to project specific data management including long-term archiving of data products and software evaluation tools beyond the scope of the project. WDCC/DKRZ contributions are located in WP1, WP2 and WP4.

Principal personnel involved

Michael Lautenschlager has a university degree in physics, a PhD in meteorology. He has been working at MPI-M and DKRZ since 1986 in the field of climate modelling and scientific data management.

Stephan Kindermann holds a PhD in computer science. He has been working at DKRZ since 2004 in the area of e-science infrastructures and data management.

Selected relevant publications

Toussaint, F., **M. Lautenschlager** und H. Luthardt, 2007: World Data Center for Climate – Support for the CEOP Project in Terms of Model Output. *Journal Met. Soc. Japan*, Vol. 85A, pp. 475-485.

Lautenschlager, M. and W. Stahl, 2007: Long-Term Archiving of Climate Model Data at WDC Climate and DKRZ. In: E. Mikusch (Ed.): PV2007 – Ensuring the Long-Term Preservation and Value Adding to Scientific and Technical Data, Conference Proceedings. DLR, German Remote Sensing Data Center, Oberpfaffenhofen.

Lautenschlager, M. (2008): Preservation of Earth System Model Data. Digital Preservation Europe, Briefing Paper 30th June 2008 (URL: http://www.digitalpreservationeurope.eu/) .

Kindermann, S., and M. Stockhause and K. Ronneberger, 2007: Intelligent Data Networking for the Earth System Science Community, German e-Science Conference 2007, Baden-Baden, May 2007.

Kindermann, S., and Martina Stockhause, 2008: A collaborative environment for climate data handling, Geoinformatics 2008—Data to Knowledge, Proceedings: U.S. Geological Survey Scientific Investigations Report 2008-5172, Potsdam, June 2008.

B.2.3 Consortium as a whole

B.2.3.1 Quality of the consortium

The EUCLIPSE consortium comprises leading European Institutions: involved are research institutes, universities and operational meteorological institutes. The consortium has a broad base of expertise with world leading scientists on the different disciplines involved in this multidisciplinary project. Within all the different disciplines the partners have a strong expertise and a long history of collaboration:

- *Earth System Model simulations*: the EUCLIPSE partners that will carry out the ESM experiments (MPG, CNRS-IPSL, METO, ECMWF, KNMI, MF-CNRM) have a long expertise in Earth system modelling and provided climate projections for the 4th assessment report of IPCC and the proposed runs in this proposal are approved by CMIP5 and will provide input for the 5th assessment report of IPCC. These partners have closely collaborated in past and present FP European Programmes such as EC-CLOUDS, EUROCS (FP5), ENSEMBLES (FP6) and COMBINE (FP7). These partners are also involved in CFMIP and in GCSS (EUCLIPSE includes the main coordinators of CFMIP and GCSS).

- *Observations and Evaluations:* EUCLIPSE includes institutes with key scientists that are specialists in exploiting the wealth of new observations of clouds. Alejandro Bodas-Salcedo (METO) is the lead developer of the CFMIP Observational Simulator Package (COSP) which is to be used in the forthcoming ESM intercomparison projects to facilitate the evaluation of ESMs with new satellite data from CloudSat and CALIPSO. George Tselioudis and Sandrine Bony are experts on model evaluations with using new techniques such as cloud clustering methods and compositing techniques. Institutes like CNRS-IPSL and KNMI have strong expertise in the ESM evaluations using advanced ground based remote sensed profiling stations (Cabauw and SIRTA) as have been proven in previous FP5 programmes like CloudNet. Frédéric Hourdin (CNRS-IPSL) and Françoise Guichard (MF-CNRM) are experts in the model evaluation of tropical cloud systems over West Africa such as observed during the observational campaign AMMA. Bjorn Stevens (MPG) has led various field campaigns of marine boundary layer clouds such as RICO and DYCOMS-II. Johannes Quaas has developed and applied pioneering process-oriented model evaluation techniques for aerosol-cloud interactions using satellite data.

- *Numerical Weather Prediction:* Tim Palmer (ECMWF) is at the forefront of developing seamless prediction techniques and of exploring their potential for unifying weather and climate prediction. By using NWP techniques such as initial tendency diagnostics, biases in the fast processes such as all the cloud related processes, can be detected in an efficient way. Applying these techniques to ESMs is new and promising.

- *Simulations at Cloud Resolving Scales:* Several partners (KNMI, MPG, METO, TUD, UW) have long lasting collaborations within GEWEX Cloud System Studies (GCSS) on cloud resolving simulation studies to specific questions in the analysis of Earth System Model Experiments. The project coordinator (A. Pier Siebesma) is currently chair of GCSS and has a 15 year experience in the use of process studies with LES models as to improve the representation of cloud processes in ESMs which has led to significant improvements of the performance of ESMs , many of which are part of EUCLIPSE.

- *Idealisations:* Bjorn Stevens (MPG) and Sandrine Bony (CNRS-IPSL) have extensive experience with idealized simulations with ESMs (both 3d and 1d) providing deeper understanding in the complex interplay between cloud processes and the large scale circulations.

All these above described communities have worked until recently in relative isolation and EUCLIPSE offers a unique opportunity to combine all these expertises leading to new techniques, both in the experimental design and in the analysis of climate model data; and finally to develop diagnostics and metrics for the evaluation of cloud-climate feedbacks. The various communities organized in GCSS and CFMIP have crossed their paths and have recently joined their forces and expertise. These joint efforts were instrumental in the development of an experimental plan and sets of required output which recently won approval by the Working Group on Coupled Modeling (WGCM) and which helps focus, among other things, the CMIP-5 experiments on cloud feedbacks (e.g., Taylor et al. 2008). EUCLIPSE is a further outcome of these joint efforts, as should be evident by its composition, both in terms of planned activities and major participants. EUCLIPSE will take advantage of these spontaneous collaborations, and help build capacity for a strong European consortium that embodies the different research communities and their tools. Ultimately this will lead to significant improvements in the evaluation and understanding of the cloud-climate feedback, the most uncertain climate feedback mechanism.

B.2.3.2 Complementarity of the consortium

EUCLIPSE will achieve its goals by assembling a team with diverse expertise and skills. The breadth of the expertise is already outlined in the previous section, reaching from observations, evaluation techniques to modelling techniques on various spatial and temporal scales, from numerical weather prediction to climate prediction, from model analysis to understanding of the underlying processes.

The choice to include several ESMs has been made on purpose. By including several (5) ESMs it is possible to make assessments on the spread in cloud climate feedback for an ensemble of ESMs. The motivation for including more than one LES modelling institute in EUCLIPSE is taken from past experience with LES intercomparison studies based on observations such as conducted over the last 15 years in GCSS. Only through running an ensemble of different LES models for a case study, confidence can be obtained on the reliability of the model results. So in conclusion, the overlap of utilizing several ESMs and LES models in the consortium is done on purpose as a strategy to prevent vulnerability to spurious results of individual models.

B.2.3.3 Suitability of partners for participation in a European project

Virtually all partners have a long experience in either coordinating or contributing to EC projects so that smooth running of EC-related reporting (scientific, technical and financial) is expected.

B.2.3.4 Geographical origin of partners

The consortium comprises a total of 12 partners from 9 European countries (Table 2.3.4)

Table 2.3.4. Country of origin of participants

Country status	No.	Countries of Participants
EU Member States	8	France, Germany, Greece, Italy, Netherlands, Poland, Sweden, United Kingdom
Associated Countries	1	Switzerland

B.2.3.5 Subcontracting

Some beneficiairies (Partners 1,2 and 4) have a small budget for subcontracting with respect to audit costs. A Mandatory Certificate on financial statements for these partners are requested as their requesting funding represent more than 375.000 Euro.

B.2.3.6 Third Parties

No third parties are represented in EUCLIPSE. The management structure allows including new partners at a later stage. This process will depend on the Management Board.

B.2.4 Resources to be committed

EUCLIPSE requires a total budget of around 5.0 million € . The total request of the EUCLIPSE consortium to the EC amounts to 3.5 million € (cf. form A3.2). EUCLIPSE represents good value for money thanks to its far reaching expected impact for all stakeholders actively engaged in climate change issues such as described in section 3 on Impact. By giving scientists, policy makers and infrastructure developers access to improved climate information, new bounds on uncertainties on this information and new evaluation tools, savings across Europe could measure in billions of euros.

Most of the total budget (around 85%) is used to hire personnel for RTD (including overhead) and will be spent on science, to make available the acquired knowledge, the newly developed evaluation tools and the climate model and observational data sets. The other 15% will be spent on management (5%), on travel (6%) and on data storage (4%).

B.2.4.1 Justification of resources by the work packages

WP	Name	Total k€	Person Months
0	Management	245	29
1	Evaluation Techniques and Climate Model Experiments	542	75
2	Climate Model Evaluation	952	144
3	Process-Level Evaluation	770	136
4	Sensitivity Experiments and Hypothesis Testing	991	127
total		3500	511

Table 2.4.1. Breakdown of the total grant requested to the EC amongst the different EUCLIPSE WPs.

The total grant requested from the EU (3.5 million €) broken down per Work Package is shown in Table 2.4.1. Most of the work done in WP1, i.e. the executions of the ESM simulations, the development and implementation of the evaluation tools will take place during the first 18 Months of this WP (see the Gantt chart). During remaining 18 months of this WP, only DKRZ will be actively working on data quality control, web-based data portals and documentation of the data and evaluation tools. It is for this reason that the costs and person months for WP1 is smaller than for WP2-4. Work packages 2,3 and 4 all have a duration of 36 months and have comparable person man months. The differences in the requested amount for these 3 packages are simply due to the different personnel costs of the involved institutes. The management costs for WP0 is for overall financial management and coordination while a small part (11 k€) is reserved for costs for audit certificates for the participants.

B.2.4.2 Storage of data and evaluation tools

Most of the data storage costs is required by DKRZ. DKRZ will archive and disseminate the data from the ESM experiments, the developed evaluation tools and observational data. From required 110 k€, 70 k€ is reserved for 50 Tbyte of disk space, which is the estimated amount of data delivered by the EUCLIPSE ESM experiments. The remaining 40 k€ is used for operational costs (electricity, maintenance and operations of data services at DKRZ.
Since most of the ESM experiments executed in EUCLIPSE are part of CMIP5, PCMDI will also contribute to the ESM data hosting. No costs are associated with this part of the data archiving as is emphasised in a letter of PCMDI that can be found in Appendix B. The LES model data that are generated in WP3 will be also hosted at he GEWEX Cloud System Study Data Integration for Model

Evaluation (GCSS-DIME) web site. No costs for the EU will be associated with this archiving exercise. Finally some partners, as indicated in Table 2.4.2 require limited material costs for hard disk space for local data storage at their institutes.

partner	KNMI	CNRS-IPSL	AA	MF-CNRM	DKRZ	total
Data storage costs (k€)	10	8	15	30	110	173

Table 2.4.2. Required costs of EUCLIPSE partners for data storage

B.2.4.3 Travel Costs

Support of travelling and subsistence is needed for attending project meetings and workshops and for presenting EUCLIPSE results on conferences. As indicated in Table 2.4.3 The partners that are active in most WPs during the full 54 months period require travelling support in the range of 20 to 30 k€ for the whole duration of the project. This is reasonable as within EUCLIPSE there are 5 meetings plus an international workshop planned, that will be visited by usually 2 to 3 representatives from each of the participating institutes. Partners contributing for a shorter period to EUCLIPSE require less travelling support in a proportional manner. The travel costs for KNMI (32 k€) is slightly higher than the other partners as requires additional travel costs for the coordinator. Additionally 42 k€ is reserved for inviting the advisory board to the annual General Assembly. As it is expected that some members of the advisory board (including members from outside Europe) to the annual General Assembly.

partner	KNMI	MPG	METO	CNRS-IPSL	AA	ECMWF
Travel costs (k€)	32+42	24	25	20	25	25

TUD	MF-CNRM	SU	ETHZ	UW	DKRZ	total
23	30	5	3	16	6	276

Table 2.4.3. Required costs of EUCLIPSE partners and advisory board for traveling

B.2.4.4 International Summer-School

The EUCLIPSE ***summer-school*** on cloud-processes and climate feedbacks will provide an important way of disseminating the science findings and tools to a new generation of scientists. The material of the summerschool, including presentations, tutorials, model and observational data will be made available on the web. An ***edited book*** from this school will further advance the dissemination goals of the project. The costs for these activities are estimated to be 30 k€.

B.2.4.5 Computing Costs

The requested budget does not include the substantial costs incurred for the execution of the ESM and LES simulations. These costs for CPU time on supercomputing facilities will be brought into EUCLIPSE by the partners and external sources. The associated costs are difficult to anticipate, and hence are not quantified here.

B.3 Impact

B.3.1 Expected impacts listed in the work programme

The world recognizes that the consequences of global climate change constitute one of the most important threats facing humanity. The response of climate to natural and anthropogenic forcings can lead to serious threats to water resources, food security, energy, transport, environment, and health. To develop adaptive strategies over the next decades and to underpin mitigation strategies and decision-making throughout the 21st century, the climate scientific community has to provide improved global climate information to the society and to policy makers. By assessing the reliability of ESMs predictions at the global and regional scale, as well as at the process scale, and by proposing strategies to improve the predictive skill of climate and weather prediction models, EUCLIPSE is expected to play a key role in that process.

Improved evaluation of Earth System Models

Errors in the representation of cloud and moist processes by Earth System Models currently represent a major impediment to our ability to make accurate climate simulations of the current climate and reliable projections for the 21st century. Through process-oriented evaluation of Earth System Models EUCLIPSE will develop our understanding of cloud-related processes and their role in the Earth-System. This knowledge will be used to define, test and disseminate standard diagnostics and metrics for evaluating cloud-climate feedbacks. Through this process EUCLIPSE will improve and constrain representations of cloud-related processes in ESMs, for instance the spatial distribution of radiant energy, patterns of precipitation, and European temperature extremes, thereby narrowing and rationalising estimates of uncertainty in projections of future climate. In addition, due to the hierarchical (in terms of spatio-temporal scales) character of the EUCLIPSE approach such evaluations will impact the representation of cloud-climate-related processes across the hierarchy of spatio-temporal scales, from the diurnal cycle of convection, convectively coupled processes such as the Madden-Julian Oscillation, to monsoon circulations and ENSO. Perhaps most significantly, a better evaluation and understanding of factors controlling cloud-climate feedbacks can be expected to improve the representation of the complex of feedbacks (aerosol, biosphere, carbon-cycle, etc.) embodied by modern Earth System Models.

The five ESMs directly participating in EUCLIPSE will experience the greatest impact, but indirectly Numerical Weather Prediction (NWP) models and limited-area (regional) climate and weather prediction models in- and outside Europe will also benefit from the diagnostic techniques, data constraints and advanced physical insights developed through EUCLIPSE.

Better exploitation of ESMs simulations by the users' community

The global climate projections provided by ESMs are used by a wide community of users, in particular by the scientific communities making regional climate projections (regional models are often forced by large-scale simulations from ESMs), assessing the impacts of climate change on water resources, food security, energy supply and air quality, or developing mitigation strategies for greenhouse gas emissions. An optimal use of the climate information provided by ESMs requires an assessment of the reliability of the different ESMs projections depending on the climate parameter, the region and the timescale of interest.

By developing a set of metrics to quantify the ESMs' ability to represent clouds, precipitation and radiation, EUCLIPSE will help these communities to assess the quality and the reliability of the different ESMs' simulations available. Thereby, EUCLIPSE will contribute to a more optimal exploitation of ESMs' projections by both other researchers and policy makers.

Changing the landscape of Earth-System Science within Europe

In Science, progress often results from the development of links between different communities. A wide scientific community is involved in cloud research, either at the scale of detailed cloud processes or at the large-scale, either from the observational or modelling sides, either from the climate or NWP perspective. Cloud-climate feedbacks remain one of the largest uncertainty for climate change projections, and while each of these communities is keen to help reducing this uncertainty, bridges have been missing to make these different communities effectively work together and achieve progress on the problem.

All these communities are represented in EUCLIPSE, and have begun to collaborate during the last two years through the CFMIP-2 project, endorsed by WGCM, GEWEX and WGNE panels. By building bridges between these different communities (*e.g*. satellite simulators to bridge the large-scale modelling and observations communities; detailed cloud diagnostics to bridge ESMs, fine-scale process models and *in-situ* observations; idealised simulations to bridge the large-scale climate community to the fine-scale modelling community and theoreticians; global ESM evaluations in forecast mode to link the climate and NWP communities), EUCLIPSE will be a catalyst of collaborations, and the consortium will make efforts to strengthen these collaborations beyond the project and beyond European borders (in that regard, the participation in EUCLIPSE of several coordinators of international projects will be particularly helpful). As such EUCLIPSE will change the very nature in which Earth System Science is pursued within Europe, as the links and connections developed through this project can be expected to be enduring.

Impact on the Fifth Assessment Report of the IPCC and further modeling activities

EUCLIPSE will start a few years before the publication of the AR5. At a recent scoping meeting in July 2009 it has been decided that there will be a separate chapter on Clouds and aerosols in AR5 with a particular focus on the role of clouds and moist processes in climate, their evaluation in models, consequences of the climate model's deficiencies and learned lessons from process models. The input for this chapter will be very directly linked to the activities such as planned in EUCLIPSE. As a result, the peer reviewed articles and reports on the evaluation and metrics of ESMs at the large-scale and at the process-scale, and the analyses of cloud-climate feedbacks developed in the project will directly and substantially contribute to several aspects of the next climate change assessment: the evaluation of climate models, the understanding and the assessment of climate sensitivity and feedbacks, and more generally of climate projections.

Besides and beyond the AR5, EUCLIPSE will disseminate tools, analysis methods, simulations and observations (e.g. satellite simulators, data from advanced profiling stations, field campaigns and satellites, high-resolution -LES- model simulations) and that will provide a useful data base for the model development community at large and a critical test toolkit for evaluating ESMs and NWP models for many years to come.

In Section 3.2 it will be further detailed how this output will be disseminated to users beyond EUCLIPSE through links with other international programmes.

B.3.1.1 Why a European Programme and why now?

Several elements make us think that a substantial advance in the improvement of model's physical parameterizations and in the understanding and the evaluation of cloud feedback and precipitation processes is now possible over the next few years and the European climate research community such as organised in EUCLIPSE is in an excellent position to take a lead in this initiative

- Due to a steady growth in computational capacity, climate model simulations can be done routinely on a finer scale, allowing for and demanding more physically-based parameterizations of the unresolved processes that will still exist for the foreseeable future. This advancement of computational capacity makes it possible to greatly enhance the large degree of empiricism that still exists in many parameterizations, of which many date back to the seventies. As Europe hosts several global climate modelling centres, an international, coordinated effort such as EUCLIPSE is highly desirable. Moreover, EUCLIPSE is in an excellent position to exploit links between climate models and Numerical Weather Prediction

(NWP) models (UK Met Office, Météo-France, and ECMWF). In addition the tremendous progress made in dealing with the complex software infrastructure of ESMs (in each institution and via several EU funded projects like PRISM, METAFOR or IS-ENES) now makes it possible for projects like EUCLIPSE to concentrate on climate science issues.

- We are currently entering the "Golden Age of Earth's observations", with the arrival in particular of novel satellites and instruments that allow for the first time the evaluation of the vertical distribution of clouds and their precipitation characteristics together with the different atmospheric and cloud optical properties affecting the radiative effects of clouds. Some of the most innovative relevant new satellites and instruments are either European or joint projects involving European partners (e.g. CALIPSO, SEVERI, GERB, IASI and from 2012 EarthCARE). Furthermore, important new observing facilities emergence within Europe that can support targeted field work. This includes the new aircraft fleet (EUFAR) with new jets in Germany, UK and France, but also advanced ground-based remote sensing atmospheric profiling stations (Chilbolton, Cabauw, Lindenberg and Palaiseau) that have been contributing to the previous successful European FP5 project CloudNet, that aimed to distribute cloud observations to the climate modelling community. EUCLIPSE aims at providing bridges between these communities hence further strengthening the European position in this research area.

- Finally there is a "critical mass" of European scientists who are leaders in the field of cloud physics, both in the area of cloud process studies (internationally organised within GEWEX Cloud System Studies, GCSS) and in cloud-climate feedback studies (internationally organised within the Cloud Feedback Model Intercomparison Project, CFMIP). The GCSS and CFMIP communities cross their paths and interact around the CFMIP-2 project (http://www.cfmip.net) focused on the study and the evaluation of cloud processes, and their implication for climate change projections. They also wish to pursue and extend the collaborations developed within the framework of the (very successful) European projects EUCREM and EUROCS, and, more recently, during AMMA. As a result, a mature network largely centered in European institutions, has emerged to deal with these problems, in part as a result of collaborations, within the context of previous framework projects. Having a good number of experienced scientists distributed across Europe means that not only will we be able to build effective collaboration, but also "seed" development of this area Europe-wide and beyond.

B.3.1.2 Links with international programmes

EUCLIPSE has strong links with a number of international programmes which will be used to further disseminate the results and impacts of the project. As stated before, EUCLIPSE is designed to build further on existing plans and capacity such as the CFMIP-2 project that grew out of a 2-year planning period by representatives from GCSS and CFMIP. These plans have been endorsed by WGCM, GEWEX, and by the Working Group on Numerical Experimentation (WGNE). The proposed ESM simulation protocols and diagnostics are part of the Coupled Model Intercomparison Project (CMIP5) and PCMDI has agreed to host the ESM simulation results (see Appendix B which contains a letter of support of PCMDI). As a result it is expected that the results of EUCLIPSE will directly contribute to the 5th Assessment Report of the IPCC.

GEWEX Cloud System Studies (GCSS) will likely adopt many of the proposed process model inter-comparison studies described in WP3 which will ensure further use and dissemination of these process studies beyond the EUCLIPSE community. The task of the GEWEX Model Prediction Panel (GMPP) oversees development and improvement of cloud and land-surface parameterization schemes of GMPP Projects to ensure their successful integration into global circulation models. WGNE leads the development of atmospheric models for both climate studies and numerical weather prediction. Both WGNE and GMPP will actively assist EUCLIPSE to disseminate the model development and evaluation results to other climate and numerical weather prediction institutes world-wide. As such the co-chair of WGNE (Prof. C. Jakob) and the director of the World Climate Research Program (WCRP, Dr. Ghassem R. Asrar) have both offered to take seat in the advisory board of EUCLIPSE.

ACPC, the Aerosol, Clouds, Precipitation and Climate program is a new joint initiative between IGBP and WCRP, through their iLEAPS and GEWEX Projects. The steering committee of this initiative is heavily represented (through Lohmann, Siebesma and ACPC co-chair Stevens) in the EUCLIPSE proposal, and efforts to address cloud-precipitation-climate and aerosol-cloud-precipitation-climate interactions within EUCLIPSE will play an important role in this developing initiative.

In addition to (or indeed through its) integrative use of CloudNet sites, EUCLIPSE will establish close links with DOE's ARM programme.

The European Space Agency (ESA) is developing EarthCARE, a satellite platform hosting a cloud radar system along with a lidar, and passive remote sensing instruments. Representatives of ESA will be invited and informed on the experiences of the satellite simulators, and the acquired knowledge and software of COSP will be communicated with ESA in order to develop a similar software tool for the upcoming EarthCARE mission.

B.3.1.3 Links with ongoing FP projects

EUCAARI: EUCAARI IOP data from May 2008 is expected to contribute to the point-studies of WP3, in part through the use of the Cabauw CloudNet site.

IS-ENES: This infrastructure project is being exploited directly through one of the partner institutions, DKRZ, by building on the IS-ENES infrastructure to improve the data-infrastructure. In addition one of the WP leaders of IS-ENES leads the WP1 on this project and thus EUCLIPSE will actively use the IS-ENES portals for dissemination.

COMBINE: By concentrating on cloud feedbacks and many simulations which are complementary to coupled ESM runs being executed by COMBINE, EUCLIPSE will take advantage of the considerable institutional overlap between its member institutes and those in COMBINE to help interpret the role of cloud-related processes in mediating the effects of other Earth-System interactions.

AMMA: The use of AMMA observations, and its associated database and expertise will be used to evaluate climate models over a western African transect in WP3.

B.3.1.4 Links with previous FP projects

EUCREM, EUROCS: These successful FP4/FP5 projects on process studies has now become incorporated in EUCLIPSE through the activities of WP3

CloudNet: Use of the atmospheric profiling stations and infrastructure set up by CloudNet is essential to much of the point diagnostics work pursued in WP3.

EC-Clouds: This project ENV4-CT95-0126 entitled "Cloud Feedbacks and Validation", that led to the development of the ISCCP simulator -Webb et al. 2001- and of compositing techniques to evaluate clouds and radiation simulated by climate models and to analyse climate change cloud feedbacks (Bony et al. 2004). Results from this project underly much of the proposed science in WP2.

DYNAMITE: This FP6 project (ENV 003903-GOCE, 2005-2008) entitled "Understanding the Dynamics of the Coupled Climate System " addressed ENSO mechanisms with a number of coordinated coupled simulations in which atmosphere feedbacks where modified. This led to suggest the role of cloud feedbacks in explaining the inter-model spread in the simulation of ENSO amplitude in coupled models (Guilyardi et al. 2009b) which underlies the ENSO analysis proposed in WP2.

B.3.2 Dissemination and/or exploitation of project results, and management of intellectual property

B.3.2.1 Dissemination

EUCLIPSE will actively work to disseminate its findings and other products of its activities. A variety of dissemination methods will be employed as discussed below.

Published Documents (Scientific Papers, Reports and an Edited Book): The use of the published literature will be the dominant means by which results and findings for the project are disseminated. In addition to the scientific studies that we expect to be published in ***scholarly journals***, EUCLIPSE will make use of a new breed of ***open-access journals*** such as *GMD* (Geoscientific Model Development, published by the EGU) and *JAMES* (the Journal of Advances in Modeling the Earth System) for describing experimental prototols, diagnostic packages and technical infrastructure such as the simulator packages. Finally an ***edited book*** will be published based on lectures at the EUCLIPSE summer-school. This book will focus on clouds and climate processes, with a special emphasis on those aspects related to feedback processes in the Earth System.

Meetings, Workshops and Schools: In addition to ***workpackage (project) meetings***, EUCLIPSE will have annual general assembly meetings hosted by the different participating centres. These meetings will feature tutorials on the use of EUCLIPSE tools and diagnostic methods as they are developed. When possible ***General Assemblies*** will be held jointly with other international initiatives, such as CFMIP, GCSS, ACPC, CMMAP (the Center for Multiscale Modelling of Atmospheric Processes, a US initiative with related goals) or specialist meetings in the context of the IPCC. This will enhance the visibility of EUCLIPSE science, and minimize additional travel commitments. General Assembly meetings will also routinely invite specialists from outside the project, who in addition to the EUCLIPSE advisory board, will further advance the dissemination goals of the project. When possible EUCLIPSE meetings will be held at participating (or related) institutes and will be open and advertised widely. The EUCLIPSE ***summer-school*** on cloud-processes and climate feedbacks will provide an important means for disseminating the science findings and tools to a new generation of scientists. An ***edited book*** from this school will further advance the dissemination goals of the project. Finally active participation of EUCLIPSE scientists in ***scientific meetings*** and within other organizational frameworks will help disseminate the EUCLIPSE results. ***Special workshops*** will also be organized around specific project results. These will call attention to major findings by project participants and involve user communities, tutorials, etc., as appropriate.

Data & Tools and the EUCLIPSE Project Portal: The data-infrastructure being developed in coordination with IS-ENES project members (WP1 and DKRZ) will be disseminated through the web using data portals. In particular ***diagnostic packages and simulators will be described and distributed*** through these portals, as will simulation results both from GCMs and fine-scale (LES) models. ***The World Data Center for Climate (WDCC)*** maintained by the DKRZ, as well as the ***PCMDI data portal*** will be the primary vehicle for distributing these results, although statistics and data volumes from the fine-scale modelling activities will also be disseminated (or mirrored) using the ***GCSS DIME site***. Finally major project findings, links to tools, archives and portals will be maintained on a the ***EUCLIPSE project Portal***, a website to be maintained by the project coordinator.

Contributions to International Organizations: EUCLIPSE project members are active in a wide variety of scientific organisations, serving as ***steering committee members or chairs*** on many of the world's leading climate initiatives. These memberships, and the opportunities they present for sharing EUCLIPSE findings will be actively realised.

B.3.2.2 Management of Intellectual Property Rights (IPR)

The Data Protocol Panel will propose to the Scientific and Executive Committee a EUCLIPSE Data Protocol based on general rules that will be defined in the Consortium Agreement. The EUCLIPSE Data Protocol will aim at promoting the publication of results in scientific literature and their presentation at conferences, while protecting the intellectual property rights of the project participants.

It will regulate the access to data generated for the EUCLIPSE project. Where possible it will adopt the protocol for the archival of data in IPCC AR5 archives for the simulations qualifying for the archival in these archives.

B.4 Ethical Issues

None of the ethical issues listed in the table below apply to this proposal.

ETHICAL ISSUES TABLE

	YES	PAGE
Informed Consent		
• Does the proposal involve children?		
• Does the proposal involve patients or persons not able to give consent?		
• Does the proposal involve adult healthy volunteers?		
• Does the proposal involve Human Genetic Material?		
• Does the proposal involve Human biological samples?		
• Does the proposal involve Human data collection?		
Research on Human embryo/foetus		
• Does the proposal involve Human Embryos?		
• Does the proposal involve Human Foetal Tissue / Cells?		
• Does the proposal involve Human Embryonic Stem Cells?		
Privacy		
• Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)		
• Does the proposal involve tracking the location or observation of people?		
Research on Animals		
• Does the proposal involve research on animals?		
• Are those animals transgenic small laboratory animals?		
• Are those animals transgenic farm animals?		
• Are those animals cloned farm animals?		
• Are those animals non-human primates?		
Research Involving Developing Countries		
• Use of local resources (genetic, animal, plant etc)		
• Impact on a local community		
Dual Use and potential for terrorist abuse		
• Research having direct military application		
• Research having the potential for terrorist abuse		
I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**YES**	

B.5 Consideration of gender aspects

The EC has set a target of 40% participation of women at all levels in implementing and managing research programmes. A recent evaluation of the participitation of women in FP6 research programmes in the Woman and Science Working document (EC, 2005) indicates a participation rate of only 25 % on the expert level. A number of actions are proposed to increase the participation rate in the FP7 research programmes. The Gender Action Plan of EUCLIPSE is presented below the initial gender balance situation.

B.5.1 Diagnosis of the gender balance situation in the EUCLIPSE consortium at the stage of proposal preparation

Of all 36 experts of the 13 participitating institutes in EUCLIPSE that are named in this proposal, 12 of them are woman (33 %). One out of four workpackages is led by a woman (25%). This is a better balance than was achieved in the average FP6 research programme, but not quite the balance of 40% envisioned by the EC. In order to improve the gender balance, help combine work and private life, and improve the awareness for gender equality within the consortium, we will implement the following actions:

1. In the recruitment of EUCLIPSE postdoc's and Phd's we will have at least one woman in the selection committee and let gender play a role in the selection process.
2. We will maintain a good gender balance of the consortium through out the project.
3. Document gender ratio at all organizational levels of the project, at the beginning and end.
4. Facilitate combination of work (project events) and private life (school holidays, weekends)
    - Project events will be organized so that travelling does not interfere with weekends.
    - Project events will be held outside of holiday seasons of the participating scientists.
    - Minimize travelling, through adequate use of teleconferencing.

In addition we will help raising awareness on the gender issue by:

- Foster networking of women scientists.
- Support the promotion of women scientist to international working groups and panels in climate science.

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List of acronyms

- AA - Academy of Athens (http://www.academyofathens.gr)
- ACE 2 - 2nd Aerosol Characterization Experiment
- ACPC - Aerosol Clouds Precipitation and Climate program (http://ileaps.org/acpc/index.php?option=com_frontpage&Itemid=1)
- AIRS – Atmospheric Infrared Sounder (http://airs.jpl.nasa.gov/)
- AMMA – African Monsoon Multi-disciplinary analyses (http://www.amma-international.org/)
- AMMA-MIP – AMMA Model Intercomparison Project (http://amma-mip.lmd.jussieu.fr)
- AMIP – Atmosphere Model Intercomparison Project (http://www-pcmdi.llnl.gov/projects/amip)
- AMS – American Meteorological Society
- ANR - Agence Nationale de la Recherche (http://www.agence-nationale-recherche.fr/)
- AOGCM – Atmosphere Ocean General Circulation Model
- APE – Aqua Planet Experiment (http://www-pcmdi.llnl.gov/projects/amip/ape/)
- AR4 – Fourth Assessment Report (http://www.ipcc.ch/ipccreports/assessments-reports.htm)
- ARCMIP – Arctic Regional Climate Model Intercomparison (http://curry.eas.gatech.edu/ARCMIP/)
- ARM – Atmospheric Radiation Measurement program (http://www.arm.gov/)
- ARPEGE - Action de Recherche Petite Echelle Grande Echelle (the MF-CNRM
- atmospheric GCM)
- ASCOS - Arctic Summer Cloud-Ocean Study (http://www.ascos.se/)
- ASTEX - Atlantic Stratocumulus Transition Experiment (http://kiwi.atmos.colostate.edu/scm/astex.html)
- AVHRR - Advanced Very High Resolution Radiometer
- BBC - Baltex Bridge Cloud campaign (http://www.knmi.nl/samenw/cliwa-net/setup/bbc/)
- BOMEX - Barbados Oceanographic and Meteorological Experiment
- CALIPSO - Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (http://www-calipso.larc.nasa.gov/)
- CALTECH - California Institute of Technology (http://www.caltech.edu/)
- CCSM – Community Climate System Model (http://www.ccsm.ucar.edu/)
- CCTD - Cloud Condensate Tendency Diagnostics
- CERES – Clouds and the Earth's Radiant Energy System (http://science.larc.nasa.gov/ceres/index.html)
- CESSAR - Centre of Small Scale Atmospheric Physics
- CFMIP – Cloud Feedback Model Intercomparison Project (http://www.cfmip.net)
- CHALLENGE – Ensemble scenario simulations with the Community Climate System Model (http://www.knmi.nl/onderzk/CKO/Challenge/)
- CLIVAR - Climate Variability and Predictability (http://www.clivar.org/)
- CloudNet - Development of a European pilot network of stations for observing cloud profiles (http://www.cloud-net.org/index.html)
- CMIP – Coupled Model Intercomparison Project (http://www-pcmdi.llnl.gov/projects/cmip/)
- CMMAP – Center for Multi-Scale Modeling of Atmospheric Processes (http://www.cmmap.org/)
- CNRM - Centre National de Recherches Météorologiques (http://www.cnrm.meteo.fr/)
- CNRM-GAME – CNRM Mesoscale Modelling Group
- CNRS - IPSL Centre National de la Recherche Scientifique - Institut Pierre Simon Laplace (http://www.ipsl.jussieu.fr/)
- COMBINE - Comprehensive Modeling of the Earth System for Better Climate Prediction and Projection
- COPAL - COmmunity heavy-PAyload Long endurance Instrumented Aircraft for Tropospheric Research in Environmental and Geo-Sciences (http://dev.eufar.net/wiki/pmwiki/pmwiki.php/COPALCMS/COPALPresentation?skin=copal)
- COSMOS – Community Earth System Models (http://cosmos.enes.org/)
- COSP – CFMIP Observation Simulator Package (http://cfmip.metoffice.com/COSP.html)
- CPT – Climate Process and Modeling Team (http://www.usclivar.org/CPT/index-newcpt.html)
- CRM – Cloud Resolving Model
- CRYSTAL-FACE - The Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment (http://cloud1.arc.nasa.gov/crystalface/)

- DALES – Dutch Atmospheric Large Eddy Simulation (http://www.knmi.nl/~siebesma/LES/)
- DEM – demonstration
- DEMETER - Development of an European Multimodel Ensemble system for seasonal to inTERannual prediction (http://www.ecmwf.int/research/demeter/)
- DIME – Data Integration for Model Evaluation (http://gcss-dime.giss.nasa.gov/)
- DKRZ – Deutsche Klimarechenzentrum (http://www.dkrz.de)
- DOE – Department of Energy
- DYCOMS II- Dynamics and Chemistry of Marine Stratocumulus Phase II (http://www.eol.ucar.edu/projects/dycoms/dm/)
- DYNAMITE - Understanding the Dynamics of the Coupled Climate System (http://dynamite.nersc.no/)
- EARTHCare - joint European-Japanese mission addressing the need for a better understanding of the interactions between cloud, radiative and aerosol processes that play a role in climate regulation
- EC - European Commission (http://ec.europa.eu/index_en.htm)
- ECBILT – Intermediate complexity General Circulation Model of KNMI (http://www.knmi.nl/onderzk/CKO/ecbilt.html)
- EC-EARTH – Earth System Model based on the ECMWF integrated forecasting system (http://ecearth.knmi.nl)
- ECHAM – General Circulation Model of MPI Hamburg (http://www.mpimet.mpg.de/en/wissenschaft/modelle/echam.html)
- ECMWF – European Centre for Medium Range Weather Forecasts (http://ecmwf.int)
- ENES – European Network for Earth System Modeling (http://www.enes.org/)
- ENM - L'Ecole Nationale de la Météorologie (http://www.enm.meteo.fr/)
- ENSEMBLES - European project supported by the EC 6th Framework Programme as a 5 year Integrated Project from 2004-2009 (http://ensembles-eu.metoffice.com/index.html)
- ENSO – El Niño Southern Oscillation
- ERA – ECMWF Reanalysis (http://www.ecmwf.int/research/era/do/get/index)
- ERBE – Earth Radiation Budget Experiment (http://asd-www.larc.nasa.gov/erbe/ASDerbe.html)
- ESA – European Space Agency (http://www.esa.int/esaCP/index.html)
- ESM – Earth System Model
- ESSENCE - Ensemble SimulationS of Extreme weather events under Nonlinear Climate changE (http://www.knmi.nl/~sterl/Essence/)
- ETH D-UWIS – ETH Department of Environmental Sciences (http://www.env.ethz.ch/index_EN)
- ETHZ - Eidgenössische Technische Hochschule Zürich (http://www.ethz.ch/)
- EU – European Union (http://europa.eu)
- EUCAARI - European Integrated project on Aerosol Cloud Climate and Air Quality Interactions (http://www.atm.helsinki.fi/eucaari/)
- EUCLIPSE – European Union CLoud Intercomparison, Process Study & Evaluation project
- EUCREM - European Cloud-Resolving Modelling Programme
- EUCREX - European Cloud and Radiation Experiment (http://gcss-dime.giss.nasa.gov/eucrex-93/eucrex-93.html)
- EUFAR – European Fleet for Airborne Research (http://www.eufar.net/)
- EULAG – Eulerian LAGrangian (http://www.mmm.ucar.edu/eulag/)
- EUROCS – European Cloud Systems (http://www.cnrm.meteo.fr/gcss/EUROCS/EUROCS.html)
- FANGIO - Feedback Analysis in GCMs for Intercomparison and Observations
- FP – Framework Program
- GCM – General Circulation Model
- GCSS – GEWEX Cloud System Studies (http://www.gewex.org/gcss.html)
- GERB - Geostationary Earth Radiation Budget Experiment (http://www.sstd.rl.ac.uk/gerb/)
- GEWEX – Global Energy and Water cycle Experiment (http://www.gewex.org)
- GISS – Goddard Institute for Space Studies (http://www.giss.nasa.gov/)
- GMD - Geoscientific Model Development (http://www.geoscientific-model-development.net/)
- GMGEC - Groupe de Météorologie de Grande Echelle et Climat (http://www.cnrm.meteo.fr/gmgec)
- GMPP – GEWEX modeling and prediction panel (http://www.gewex.org/projects-GMPP.htm)
- GPCI - GCSS/WGNE Pacific Cross-section Intercomparison (http://www.igidl.ul.pt/cgul/projects/gpci.htm)

- GOCCP – GCM-Oriented Cloud CALIPSO Product (http://climserv.ipsl.polytechnique.fr/cfmip-atrain.html)
- HADGEM2-ES – Hadley Centre Global Environmental Model 2 (Earth System)
- IACETH - Institute for Atmospheric and Climate Science ETH
- IASI - Infrared Atmospheric Sounding Interferometer (http://smsc.cnes.fr/IASI/)
- IFS - Integrated Forecasting System
- IGAC – International Global Atmospheric Chemistry (http://www.igac.noaa.gov/)
- IGPB – International Geosphere-Biosphere Programme (http://www.igbp.kva.se/)
- IGFUW - Institute of Geophysics at the University of Warsaw
- iLEAPS - Integrated Land Ecosystem-Atmosphere Processes Study (http://ileaps.org/)
- IOP – Intense Observing Period
- IPCC - Intergovernmental Panel on Climate Change (http://www.ipcc.ch/)
- IPSL – Institut Pierre-Simon Laplace (http://www.ipsl.jussieu.fr/)
- IPY – International Polar Year
- IRCAAM - Etude de l'influence réciproque des climats d'Afrique de l'Ouest, du Sud de l'Asie et du bassin Méditerranéen
- ISCCP - International Satellite Cloud Climatology Project (http://isccp.giss.nasa.gov/)
- IS-ENES - INFRA-2008-1.1.2.21: establishing an European e-Infrastructure for earth system's understanding and modeling
- ITCZ – Inter Tropical Convergence Zone
- JAMES - Journal of Advances in Modeling Earth Systems
- JPL - Jet Propulsion Laboratory (http://www.jpl.nasa.gov/)
- JSC - Joint Scientific Committee
- KNMI - Royal Netherlands Meteorological Institute (http://www.knmi.nl)
- LAM – Limited Area Model
- LES – Large Eddy Simulation
- LLNL – Lawrence Livermore National Laboratory (https://www.llnl.gov/)
- LOCEAN – Laboratoire d'Océanographie et du Climat : Expérimentations et Approches Numériques (https://www.locean-ipsl.upmc.fr/index.php)
- LMD – Laboratoire de Météorologie Dynamique (http://www.lmd.jussieu.fr/)
- LMDz - Laboratoire de Météorologie Dynamique general circulation model
- MB – Management Board
- METAFOR – Common Metadata for Climate Modelling Digital Repositories (http://metaforclimate.eu/)
- METO - Met Office (http://www.metoffice.gov.uk/)
- MF-CNRM[21] - Météo-France - Centre National de Recherches Météorologiques (http://www.cnrm.meteo.fr/)
- MGT - management
- MISR - Multi-angle Imaging SpectroRadiometer (http://www-misr.jpl.nasa.gov/)
- MISU – Department of Meteorology Stockholm University (http://www.misu.su.se/)
- MIT – Massachusetts Institute of Technology (http://web.mit.edu/)
- MJO – Madden-Julian Oscillation
- MLS – Microwave Limb Sounder (http://mls.jpl.nasa.gov/)
- MODIS - Moderate Resolution Imaging Spectroradiometer (http://modis.gsfc.nasa.gov/)
- MODOBS - Atmospheric modelling for wind energy, climate and environment applications: exploring added value from new observation technique (http://www.modobs.windeng.net/)
- MOHC – Met Office Hadley Centre (http://www.metoffice.gov.uk/research/hadleycentre/)
- MPG - Max Planck Gesellschaft (http://www.mpg.de)
- MPI-M – Max Planck Institute for Meteorology (http://www.mpimet.mpg.de/)
- NASA – National Aeronautics and Space Administration (http://www.nasa.gov/)
- NEMO - Nucleus for European Modelling of the Ocean (http://www.nemo-ocean.eu/)
- NWP – Numerical Weather Prediction
- OAGCM - Ocean-Atmosphere Global Climate Model
- PACE - Parameterization of the Aerosol Indirect Climatic Effect

[21] CNRM is also affiliated to the Centre National de la recherché Scientifique (CNRS) under the name of Groupe d'Etude de l'Atmosphère Météorologique (GAME)

- PAM – Project Assistant Manager
- PARASOL - Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar (http://smsc.cnes.fr/PARASOL/)
- PC – Project Coordinator
- PCMDI – Program for Climate Model Diagnosis and Intercomparison (http://www-pcmdi.llnl.gov/)
- POLDER - POLarization and Directionality of the Earth's Reflectances (http://smsc.cnes.fr/POLDER/index.htm)
- PREDICATE – Mechanisms and Predictability of Decadal Fluctuations in Atlantic-European Climate (http://ugamp.nerc.ac.uk/predicate/)
- PRISM - PRogramme for Integrated earth System Modelling
- PROVOST - Prediction Of climate Variations On Seasonal to interannual Timescales
- QUANTIFY - Integrated FP6 project dealing with the climate impact of transport
- RICO – Rain in Cumulus over the Ocean (http://www.eol.ucar.edu/projects/rico/)
- RTD – Research and technological development
- RTTOVS – Radiative Transfer for TIROS Operational Vertical Sounder
- SAB - Scientific Advisory Board
- SCM – Single Column Model
- SEVERI - Meteosat Second Generation Satellite
- SGP – Southern Great Plains
- SINTEX - Scale Interaction Experiment
- SIRTA - Site Instrumental de Recherche par Télédétection Atmosphérique (http://sirta.ipsl.polytechnique.fr/)
- SPEEDO – Intermediate complexity coupled AOGCM
- SPM – Summary for Policy Makers
- SSC – Scientific Steering Committee
- SST – Sea Surface Temperature
- SU - University of Stockholm (http://www.bbcc.su.se/)
- TAR – Third Assessment Report (http://www.ipcc.ch/ipccreports/assessments-reports.htm)
- TOA – Top Of Atmosphere
- TRMM – Tropical Rainfall Measuring Mission (http://trmm.gsfc.nasa.gov/)
- TUD - Delft University of Technology (http://www.ws.tn.tudelft.nl)
- UCLA – University of California, Los Angeles (http://www.ucla.edu/)
- UKMO – United Kingdom Meteorological Office (http://www.metoffice.gov.uk/)
- UW - University of Warsaw (http://www.uw.edu.pl/en/)
- VOCALS – VAMOS Ocean-Cloud-Atmosphere-Land Study (http://www.eol.ucar.edu/projects/vocals/)
- WCRP – World Climate Research Program (http://wcrp.wmo.int)
- WDCC - World Data Centre for Climate (http://www.mad.zmaw.de/wdc-for-climate/)
- WGCM – Working Group on Coupled Modeling (http://www.clivar.org/organization/wgcm/wgcm.php)
- WGNE – Working Group on Numerical Experimentation
- WMO – World Meteorological Organisation (http://www.wmo.int)
- WP – Workpackage
- WU – Uniwersytet Warszawski (http://www.uw.edu.pl/)