EUCLIPSE

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Attachment(s)

Participants:

Bjorn Stevens (MPI), Kumar Cheedela Suvarchal (MPI), Sandrine Bony (IPSL), Frederique Cheruy (IPSL), Marjolaine Chiriaco, (IPSL), Mark Rodwell (ECMWF), Roel Neggers (KNMI), A. Pier Siebesma (KNMI), Stephan de Roode (TU Delft), Julien Cattiaux (CNRM/Meteo France)

October 6-7 2011

Summary of WP2-WP3-WP4 discussions

Purpose:

i) planning of the implementation of the upcoming tasks for WP2/WP3/WP4 and WP4 for the coming year,
ii) planning of joint cross-cutting activities especially for WP4.

1. WP2 discussion

Representatives from CNRM, KNMI, MPI and IPSL presented an overview of their contribution to WP2 tasks. Sandrine presented the contributions of the Hadley Centre, of MISU and of the Academy of Athens based on the material they provided in advance of the meeting. A synthesis of these presentations is given here. Emphasis is given to the upcoming tasks and deliverables for the coming year.

1.1 Contributions to the Tasks

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.

* The Hadley Centre (Alejandro Bodas-Salcedo, Yoko Tsushima) plans to carry out: (i) a multi-instrument, multi-model evaluation of clouds against satellite observations, following the work in Bodas-Salcedo et al. (BAMS, 2011), and (ii) a multi-model analysis of extratropical cyclones using the methodology of Field et al. (QJRMS, 2011) and Bodas-Salcedo et al. (in preparation). Among the key questions that will be addressed in these studies are: Which clouds are

responsible for the SW bias in the Southern Ocean? How do the radiative properties of extratropical systems change under idealized forcings? In addition to this, Yoko Tsushima proposes to produce a webpage which will list various cloud-oriented metrics published in scientific journals, including those derived from the work of Williams and Webb (2009) or Tsushima et al. The main goal will not be ranking the models, but trying to get an overview of the evaluation of model clouds. Whether these metrics are discriminating of cloud feedbacks will be also investigated.

* MISU (Gunilla Svensson, Michael Tjernström and Johannes Karlsson) plans to evaluate Arctic clouds simulated by CMIP5 models, especially the change of the atmospheric state and cloudiness with sea-ice. Among the key questions that will be addressed: How well are the Arctic states simulated by the CMIP5 ensemble (frequency vs absolute values)? Do we see any shifts in the future projections? What role do clouds play? The model-observations diagnostics developed for polar clouds will contribute to the metrics activity.

* IPSL (Hélène Chepfer, Gregory Césana, Christine Nam, Romain Roehrig, Jean-Louis Dufresne, Sandrine Bony) plans (i) to use several datasets (especially CALIPSO, PARASOL and CERES observations in addition to meteorological analyses) and COSP outputs to assess the simulation of clouds in CMIP5 models (after a quality check of lidar COSP outputs, the main focus of analyses will be put on tropical clouds, and maybe on polar clouds as well), (ii) to retrieve information about the cloud phase from CALIPSO observations and to develop an updated version of the lidar COSP simulator to diagnose the phase from model outputs (modelling groups volunteer to test this updated version of the lidar simulator in their model should contact Helene Chepfer). Among the key questions that will be addressed by these studies: Can we interpret compensating errors between low-cloud fraction and optical depth? Can we put observational constraints on the cloud phase simulated by climate models? Can we design observational diagnostics relevant to evaluate some components of cloud feedbacks?

* The Academy of Athens (George Tselioudis and Dimitra Konsta) will use a new compositing methodology (Bauer and Tselioudis 2011) to analyze extratropical storms and their impact on radiation and precipitation. The same methodology will be applied to climate model outputs for evaluation. Studies of midlatitude cloud/radiation/precip changes with storm strength/frequency will be performed, and will be used for model evaluation.

* KNMI (Carlo Lacagnina, Frank Selten and Pier Siebesma) will use COSP outputs and satellite observations together with a multi-compositing methodology to analyze and to evaluate interannual variations of clouds simulated by climate models in the tropics.

* MPI will evaluate the cloudiness simulated by ECHAM using COSP outputs, and will analyze Southern ocean biases, including the role of clouds/sea-ice interactions.

* No information was reported about ETH activities.

Based on these different plans, it was proposed that one cross-cutting activity across EUCLIPSE WP2, WP3 and WP4 would be the characterization of cloud biases and compensating errors in climate models, with an initial focus on the "too few, too bright low-cloud problem" (see the meeting report on cross-cutting activities).

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.

* CNRM (Gilles Bellon, Julien Cattiaux, Hervé Douville and Boutheina Oueslati) will study the role of cloud and moist processes in (i) the double ITCZ problem of climate models (in coupled, atmospheric and aqua-planet models), (ii) in the simulation of intraseasonal variability (MJO), and (iii) the simulation of temperature extremes over Europe (including the role of soil moisture, large-scale circulation and cloud processes). For the Deliverable 2.4, the simulation of the ITCZ and of MJO in EUCLIPSE/CMIP5 GCMs will be evaluated.

* MPI (Benjamin Möbis, Traute Crueger, and Bjorn Stevens) has analyzed simulations from various versions of the ECHAM model (differing by their convection scheme, their resolution or the ocean-atmosphere coupling) and have come up with some hypotheses regarding the role of the representation of convective processes in the ability of

models to simulate a single/double ITCZ and a proper MJO. These hypotheses will be tested further using multi-model experiments as part of WP2-WP4 cross-cutting activities.

* IPSL/LOCEAN (Hugo Bellenger and Eric Guilyardi) evaluate the ability of climate models to simulate ENSO based on a wide range of CLIVAR metrics. These metrics show that like CMIP3 models, CMIP5 models still exhibit a large diversity of ENSO behaviours (this work will contribute to Deliverable 2.4). Model strengths or weaknesses are interpreted using process-oriented metrics (e.g. by evaluating the so-called Bjerkness heat-flux feedbacks). They will analyze in particular the role of clouds in model errors and in inter-model differences in the heat flux feedback.

* IPSL/LMD (Sandrine Bony, Frederique Cheruy and Solange Fermepin) will study the influence of cloud-radiative effects on the large-scale tropical circulation and on the distribution of precipitation. Some idealized experiments have been run with the IPSL model for this purpose, that will be proposed to other modelling groups as part of a cross-cutting activity. In parallel, the sensitivity of clouds to land-surface processes over Europe was investigated in atmospheric simulations nudged by meteorological analyses.

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

* Hadley Centre (Tim Andrews, Mark Ringer, Mark Webb): The spread of climate sensitivity, forcing and feedbacks among CMIP5 models will be diagnosed using the Gregory et al. (2004) method. Mechanisms of climate change cloud feedbacks in CMIP5 models will be studied using a large range of CMIP5/CFMIP2 model outputs.

* MPI (Malte Riecke, Louise Nuijens and Bjorn Stevens) have used a LES model in an idealized configuration to unravel the mechanisms underlying the response of shallow cumulus clouds to global warming in a nearly constant relative humidity atmosphere. The possible reasons for the drying of the boundary layer with a warming climate will be investigated further in the future as part of a WP2-WP4 cross-cutting activity.

* IPSL (Sandrine Bony, Florent Brient, Jean-Louis Dufresne and Vanessa Vial): by analyzing the climate change cloud feedback predicted by the IPSL model in a range of configurations, several key physical mechanisms underlying the positive cloud feedback have been unravelled, and the robustness of the feedback (e.g. its sensitivity to tuning parameters) has been investigated. Future work will consist in investigating whether similar cloud feedback mechanisms are at work in other CMIP5 models, and in designing observational tests relevant for assessing some components of the models' feedback. In parallel, the physical and dynamical mechanisms underlying precipitation changes in climate change will be investigated with the aim of better understanding the robust and uncertain components of precipitation projections in the tropics.

* MISU will analyze how clouds respond to (and feedback on) climate change in the Arctic. In particular, it will be investigated whether climate projections are associated with shifts in the Arctic atmospheric states, and how clouds interact with sea-ice under climate change.

* The Academy of Athens will analyze the responses of extratropical clouds and precipitation to climate change by using an original methodology to define the storms area (Bauer and Tselioudis 2011). The relative impacts of changes in the strength and in the frequency of storms will be assessed. It should help to better assess climate change cloud feedbacks resulting from changes/shifts in mid-latitude storm tracks.

1.2 Next deliverables for WP2

- Deliverable 2.4 (due on Jan 2012, coordinated by CNRM) will include evaluations of the ITCZ structure, MJO, ENSO and European temperature extremes in EUCLIPSE/CMIP5 models. The work is already well advanced for the ITCZ, ENSO and temperature extremes. MJO evaluations might be slightly delayed.

- Deliverable 2.5 (also due on Jan 2012, coordinated by IPSL) will consist in diagnosing forcings, feedbacks and climate sensitivity in EUCLIPSE/CMIP5 models using two complementary approaches: a regression method, and a kernel approach. In addition to that, we will quantify the spread of regional cloud and precipitation projections from CMIP5 models. As far as possible, these results will be compared to CMIP3 results.

Artikel I. WP3 Discussion

The discussions on the tasks in WP3 were concentrated on those that will be intensified in the coming year. The already ongoing Task 3.1 is in full development and have been extensively discussed during the General Assembly in Exeter June 2012. The discussions have therefore been concentrated on Task 3.2 and Task 3.3.

We received input by email for the meeting from Webb, Lock (UKMO) and Guichard (MF-CNRM). Bony (IPSL), Rodwell (ECMWF), Neggers, Siebesma (KNMI), De Roode (TUD), Suvarchal (MPI) further discussed which are the most fruitful type of model evaluations.

We also discussed difficulties with the CGILS case, and how to develop frameworks that are less sensitive to how horizontal advection is represented, and/or possible two column approaches.

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

Within the various CMIP5 runs extensive output will be generated for 119 selected grid points including the AMMA and GPCI transect and the European CloudNET grid points. Especially the free climate AMIP runs and the more constrained T-AMIP will be used for a thorough evaluation with observations

Observations for the CloudNET sites have been generated in the so-called EUCLIPSE data files (http://climserv.ipsl.polytechnique.fr/fr/cfmip-observations-5.html) for the period Jan. 2008- April 2010) and observations of the GPCI and AMMA cross section are easily accessible. Extractions of instantaneous observations from multiple satellite outputs over each CFMIP grid sites (including CloudNET, AMMA and GPCI transects) are also on-going.

Dependent on the sites on which analyses will be performed, different research themes have been identified which will be detailed more below. All the following tasks will contribute to the cross-cutting issues defined at the meeting

Task 3.2.1 ESM evaluation at the GPCI

The cloud fraction will be analysed as a function of the κ-stability parameter (Kuo and Schubert 1988, Moeng 2000, Lock 2009) that includes both the temperature and humidity jumps across the inversion layer and can also be expressed in terms of the jump of moist static energy (MSE). Roel Neggers has diagnosed the SCM cloud fraction results for the four EUCLIPSE transition cases (ASTEX and the composite cases) and has found systematic differences in cloud fraction for similar the κ-analysis. A similar analysis can be performed using model output for the GPCI cross section. Note that the the κ-analysis requires information of the thermodynamic structure of the boundary layer and therefore needs re-analysis data. As the κ-analysis is a tool to categorize stratocumulus and cumulus in terms of inversion strength and since the GPCI is home of these clouds it seems natural to do this analysis at this transect.

This task will be coordinated by KNMI. Roel Neggers will be the focal point.

Task 3.2.2 ESM evaluation for the CloudNET sites.

A unique feature of the observations at the CloudNET sites is the simultaneous availability of both cloud properties and surface radiation. It is hence natural to concentrate on the relation between these properties and address the question:
How do biases of the (boundary layer) cloud properties influence surface radiative properties and the T2m temperature?

Preliminary studies with one EUCLIPSE ESM (EC-Earth) has shown that an improved cloud representation has led to a positive bias in the surface downward shortwave radiation and hence to a bias in the T2m temperature. This bias could be removed through a more realistic description of the cloud overlap assumptions in which boundary layer clouds are assumed to have a less maximum cloud overlap. This study suggests that in the original formulation of EC-Earth there is a cancelling of biased errors: An overestimation of boundary layer cloud fraction is compensated by an unrealistic cloud overlap assumption. This could be a general feature of ESMs and will be the topic of analysis for the EUCLIPSE ESMs over the CloudNET sites. This is related to the cross-cutting theme in WP4 on cloud bias characterization.

Additionally the relation between soil moisture and cloud feedback will be addressed. In other words: Is it possible to find a signature of a soil moisture feedback on cloud formation? In other words, does an underestimation of the soil humidity lead to a distinct underestimation of clouds as compared to observations?

Finally, the observations facilitate to make a comparison of the modelled surface energy balance, TOA radiation, and the hydrological cycle. The presence of remote sensing devices at the CloudNET sites facilitate a comparison of the PDFs for various cloud related quantities. For a truthful comparison an observation simulator needs to be applied to the ESM data fields.

Remark: For the analysis it is vital to include the cloud fraction in the EUCLIPSE data files.

This task will be coordinated by KNMI. Roel Neggers will be the focal point.

Task 3.2.3 ESM evaluation for the AMMA transect

The AMMA data will be used to verify the modelled diurnal cycle of convection and its relation to the formation of mid-level clouds for all EUCLIPSE ESMs

This task will be coordinated by KNMI. Francoise Guichard will be the focal point.

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

Sara Dal Gesso (KNMI/TU Delft) is exploring how the vertical stability in terms in total specific humidity and liquid water potential temperature control equilibrium states of stratocumulus cloud fraction and liquid water path. The experiments are performed using an idealized setting with a prescribed (constant) SST, and subsidence and radiation being the main large-scale forcing terms. These runs are repeated with a 2K SST perturbation. This set-up can therefore be considered as an extension of the CGILS experiments. In principle, any other forcing (horizontal advection, horizontal wind velocity) can be added, or tests using a high vertical resolution can be used, to study in a systematic way their effect on the amount of low clouds. The set up for the will be finalized by the end of 2011 and can be used for future SCM studies. A similar set of experiments can be set up for shallow cumulus clouds following Bellon and Stevens (2011).

In addition, the analysis of GCM outputs at selected locations (cfSites) in both present-day and future climates (CMIP5 AMIP and perturbed AMIP simulations) will allow us to investigate at the process-level how the simulated cloud properties change under global warming, and thus to connect the analysis of cloud feedbacks at the large-scale (WP2) to process studies (WP3).

This task will be coordinated by TU Delft and KNMI.

3. WP4 discussion

Since WP4 is centred around cross cutting activities that will follow naturally out of the findings from WP2 and WP3 we have discussed possible joint or cross cutting activities and decided that these would be emphasized in future EUCLIPSE work and help serve as a basis for organizing EUCLIPSE meetings.

Cross-cutting activities

For the cross cutting activities we identified five themes:

a. Cloud Bias characterization, with an initial focus on the too few, too bright, low cloud problem, and more compensating errors more broadly. Here we ask different groups to explore different ways to characterize this issue, preferably in a way that is not geographically specific. Specific ideas were:

- LTS vs CF or kappa vs CF to address relationship between CF and inversion strength.
- Tau/CF vs albedo and CF vs albedo in relation to the cloud overlap assumption used.

Roel Neggers will keep a focal point for this activity.

b. Low-level cloud feedbacks: There are two components to this. One is to explore the robustness of low-cloud responses, preferably by exploring the idea that the boundary layer dries in an RH sense in a warmer climate and thereby is associated with fewer clouds. Here an emphasis on regimes where omega is > 20 hPa is most interesting. The other is to explore mechanisms to test our ideas as to how this works. Here Sandrine will serve as a focal point.

c. Convection dynamics interactions: Here are two issues; one is on the relationship between the formulation of convection schemes and the placement of the ITCZ, in both realistic worlds and in aquaplanets, and how this connects to the MJO. The other is how cloud radiative forcing drives large-scale circulations. For the former both the CNRM (Bellon) and the MPI (Möbis and Stevens) groups have been working on these issues and will meet to see if a common way forward can be identified (I will serve as a contact for this). For the latter we agreed on six experiments using Aqua Planets. Three with control SSTs and three with +4K SSTs. For each experiments will be run with: (i) cloud radiation interactions disabled; (ii) cloud radiation interactions disabled for p>=700 hPa; (iii) cloud radiation interactions disabled for p<700hPa. Sandrine will serve as a focal point for this activity.

d. Simple Transpose AMIP experiments to support work at ECMWF. The experimental protocol will be defined by Mark Rodwell and Daniel Klocke, they will serve as a focal point for this.

e. Specified soil moisture experiments. Here we will explore the feasibility in our models of fixing soil moisture to explore its effects on European extremes, as opposed to cloud feedbacks. The idea is to perform AMIP runs with specified soil moisture. (Julien will serve as a contact for this.)

4. Additional issues

1. We identified open weeks in May-June for the next EUCLIPSE meeting, which would be held over four days in Paris and we agreed that the next meeting would be a EUCLIPSE meeting, but thought that it would be open to the rest of the CFMIP community and that the fourth day could be reserved for CFMIP discussions/activities.

2. We finalized the EUCLIPSE book outline and will begin recruiting authors.