IS-ENES2 DELIVERABLE (D -N°: 2.4)

3rd European School on Earth System and Climate Modelling

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	2017-05-15	SJ	Internal review comments
	2017-05-17	RGB, AW, SS	Answers to comments
2.0	2017-05-31	FG, SJ	Final version

Abstract

The Third European School on Earth System and Climate Modeling took place at the Center for Scientific Computing CSC in Helsinki, Finland, from June 08 – 22 2016, organized jointly by the National Centre for Atmospheric Research, Reading, UK, the MPI for Meteorology, Hamburg, Germany, and the Barcelona Supercomputing Centre, Barcelona, Spain under the auspices of the European Network for Earth System Modeling as part of the IS-ENES2 WP 1.

28 students, of which 16 were male and 5 non-EU, participated. Three Models were set-up, run, and inter-compared. Eighteen full lectures were given, and about 440 person-hours were spent on one-to-one tutorials. Participants were very satisfied by the school providing also insightful recommendations for any future school.

Project co-funded by the European Commission's Seventh Framework Programme (FP7; 2007-2013) under the grant agreement n°312979		
Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants including the Commission Services	
RE	Restricted to a group specified by the partners of the **IS-ENES2** project	
CO	Confidential, only for partners of the **IS-ENES2** project	

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Executive Summary

The objectives of the school were:

- To help in the scientific education and progression of early career scientists;
- To compactly introduce early career scientists and programmers to Earth System Modelling;
- To provide insight into how models work, and how they are used to support science experiments;
- To familiarize participants with model inter-comparison;

The Third European School on Earth System and Climate Modeling took place at the Center for Scientific Computing CSC in Helsinki, Finland, June 09 – 21 2016, organized jointly by the National Centre for Atmospheric Research, Reading, UK, the Finish Meteorological Institute FMI, the MPI for Meteorology, Hamburg, Germany, and the Barcelona Supercomputing Centre, Barcelona, Spain under the auspices of the European Network for Earth System Modeling as part of the IS-ENES2 WP1.

Students performed 4 types of experiments with 3 different Earth system models. After analyzing their experiments, the school closed with 4 presentations by students showing their analysis results. All students successfully completed the school. Personal communication with the students after the school, as well as surveys, showed largely positive reactions.

Due to uncertainty about future funding, currently no direct follow-up school in this series is planned. The individual organizing institutions, making use of the material available (accessible, among others, via the ENES portal), will foster local versions of the school.

1. Objectives

The Earth‘s climate is a complex natural system; accordingly models of the Earth’s Climate System (ESMs) are complex pieces of software. Young scientists working in this field are mostly educated in disciplines like meteorology or oceanography – or physics or economy, fields even farther away from Earth System Sciences – so they are introduced to ESMs only superficially, at best. A focused, coordinated teaching approach to Earth system modelling is missing in many countries throughout Europe, especially where large specialised institutions are not available. Many early career scientists have to acquaint themselves to the ESM of their - or their advisors - choice by „training on the job“, i.e. applying a model not very well known to them to a specific scientific question. Literature studies and knowledge exchange with colleagues and superiors on the job and/or during workshops and conferences accompany this occupation.

The larger Earth System Modelling institutions have seen the problem of „Teaching Earth System Modelling“ already for a longer time, and established systems like the International Max Planck Research School on Earth System Modelling at Max-Planck-Institute for Meteorology (MPI-M) in Hamburg[1] or summer schools like the National Centre for Atmospheric Sciences (NCAS) Climate modelling schools (an example can be found under http://www.ncas.ac.uk/index.php/en/climate-modelling-summer-school#).

Such summer schools share a typical structure: a series of lectures on model components that are coupled in ESMs (Atmosphere, Ocean, Land, Ice, etc.), the principal Earth System cycles (Water, Carbon etc.), but possibly also on numerical aspects, software engineering or hardware and other IT aspects, as well as more general aspects of the Earth system (political, societal etc.) combined with hands-on tutorials on the model. Sitting in a computer lab, participants are introduced to the software structure, scripts to run and control the model, tools to analyse, interpret and compare their output, and are then guided to parameterise and initiate a model run in a way enabling them to work on assignments answering typical questions in Earth System modelling (see examples below).

However, most summer schools to the date of IS-ENES’ start were mainly addressed to students from a single institution and did not train on any model inter-comparison. Additionally, some of them were open only to users of the model in question or to affiliates of the host institution. Another observation is crucial in this context: ESM scientists and also those colleagues studying impacts of climate change, independent of their career status, today need to compare ESMs and their results, as it is obvious from the numerous Model Inter-comparison Projects (MIPs), which are a unique feature and crucial part of this field of science, such as e.g. the CMIP5/IPCC process.

So, within the IS-ENES context, the idea came up to transfer the concept of successful ESM summer schools as described above, held and organised by single institutions on a single model, to a larger audience, namely early career ESM scientists throughout Europe, especially from underrepresented countries, in a series of summer schools,

[1] http://www.earthsystemschool.mpg.de/

employing not only one specific, but rather a few ESMs, and compare these models during the schools.

Within the IS-ENES consortium the institutions working on this idea first were MPI-M and Academy of Athens (AA). NCAS joined later on, and the three institutions successfully carried out together the 1st prototype of an IS-ENES summer school series in summer 2012 on the island of Kos/Greece. For IS-ENES2, AA was no longer partner in the project, but BSC, representing the EC-Earth consortium, jumped in. In 2014, the 2nd E2SCMS was carried out in Barcelona, Spain, see IS-ENES2 report D2.2.

Both NCAS and MPI-M had quite some experience running single institution/model schools already (see e.g. the NCAS reference above or http://issmes.enes.org), whereas BSC was not only volunteering to provide suitable facilities to host the second school, but also prepared a specific summer school version of the EC-Earth model as third model for the school.

NCAS, BSC and MPI-M benefitted from their activities in the first two schools in that they were able to re-use versions of their models and environments installed on their machines, and on the High Performance Computing system of the German Climate Computing Centre DKRZ for the 2nd school. BSC was able to use its own facility (Mare Nostrum HPC) for the experiments with the EC-Earth model and to post-process and analyse results. The data was transferred to CSC as a matter of backup. For this 3rd school a new version of the model was used (3.1 instead of 2.3).

This deliverable describes the 3rd E2SCMS in more detail.

2. The third E2SCMS Summer School in detail

The 3rd E2SCMS took place June 9 – 21 2016 on the University Campus in Helsinki, Finland. Preparation of the school started about 1 year in advance, with frequent video and phone conferences. New assignments were discussed and tested with the three models in advance. The application and admission process and the travel arrangements were conducted and carried out at MPI-M. A committee with participation by the three institutes involved and the project coordination selected admissions to the school. All final assignments were pre-computed, and the data stored both at DKRZ and BSC, as an emergency backup.

A field visit to the Hyytiala[2] observational field site was held during the 1st week-end. At Hyytiala the students were exposed to a number of observational techniques, international programmes, instrumentation and protocols developed at this advanced station.

2.1 Lectures

The lectures, as it is kind of best practice in this type of summer school, covered the complete Earth system, its compartments, the models describing these compartments, and their combination/coupling. These readings were accompanied by more specialised lectures on the one hand, introductions to the assignments and methods to be applied, and, on the other hand, by more generic evening lectures for the broader academic education and information. Much to the advantage of the students it was possible to attract quite a few internationally well reputed teachers for the lectures, as can be seen from the lecturers list in the addendum.

For the second time, a lecture on entrepreneurship was added (Milestone MS6.5). Antti Solonen gave it from the ENIRAM company in Finland, which tackles mitigation of climate change through optimisation of fuel for ships. This lecture provided the opportunity to students to learn by example how a company-based business concept on climate change works. The students were also introduced to IS-ENES2 and the infrastructure needs for climate modelling by its coordinator.

2.2 Tutorials

From each institution involved, at least three tutors were delegated to the school, enabling a very good tutor-student ratio and, thus, a good and fast coverage of the questions of the students. FMI also had additional staff on-site for the more technical questions and problems, which was very much appreciated.

2.3 The Agenda

The E2SCMS schools consist of teaching and training phases, see the agenda in the addendum. For the training, the following consideration is important: due to their numerical properties and performance, the models in question need to run on HPC facilities. Since the assignments for the school need to cover topics relevant in climate sciences, the data sets produced should cover at least a few decades of model time, preferably more than 100 model years. The MPI-M and NCAS models provided have a performance of about 30 - 100 years per real time day, so they need to run for two to three days in order to produce enough data for an analysis interesting for the participants. Given the length of the typical summer school (1 - 2 weeks) and the time needed to interpret the results (including to understand the assignment, find out the relevant parameters, build a hypothesis, understand and employ the analysis tools, check data against the hypothesis, prepare presentation of results, which also sums up to 1 - 2

[2] http://www.helsinki.fi/hyytiala/english/index.htm

weeks) it is obvious that the training has to be organised in a way that enables the participants to send off their job script on the HPC facility on day 1 of the school. This implies also quite a large number of tutors to help participants to come up to speed, and provide knowledge and hints to tackle the assignments. The assignments for a multi-model summer school pose a special challenge: In order to compare the models in a meaningful way, the assignments have to be set up in a way that all models can tackle them. The list of assignments is also attached.

EC-Earth has no coarse resolution configuration. Therefore the performance of the model is reduced as compared to the other two models. EC-Earth can produce 7 to 8 years per real time day. So if the school wants to provide 100 years to the students, some previous work has to be done. All assignments were computed before the school at the Mare Nostrum. At the beginning of the school the students built the model , configured it and ran a few years to see how the model was performing. To do the real analysis, the students used the 100 year precomputed output stored in Mare Nostrum disk.

Experiences from previous schools led the team to the decision to provide the teaching as early as possible in order to give the students the possibility to apply their newly acquired knowledge to the science problems posed to them, also see below. Another very important element of the school was the hypothesis building process including ample time for discussions with everyone working on them. This supported the school's concept of discovery learning. Evening talks "looking over the rim" completed the agenda.

2.4 Facilities

The location to be found for such a school has to fulfil some technical requirements: a lecture hall for about 60 people, a separate computer class room with about 16, better 32 terminals, and some separate smaller rooms for discussions of working groups are necessary. Furthermore, a fast network link to the HPC installation - and to the internet at large for research and for the daily needs of the participants - are prerequisite, as are presentation and printing facilities. Board and lodging needs also have to be fulfilled. As before, it was decided to look for a place for the school not only technically apt for the job, but also culturally interesting. This time, Helsinki was the place of choice.

The computing times, storage facilities, support services and other resources were provided by BSC, DKRZ, and NCAS. University of Helsinki made a lecture hall as well as two computing labs available. They also arranged for on-site facilities for lunches and coffee breaks. One of the computing labs was equipped with twenty PCs, the second one with ten PCs. Local as well as on-line support was provided by University of Helsinki. Technical support worked well except for the first day of the school when the participants had to work under Windows OS, because their accounts for the Linux environment had not been configured yet.

2.5 Assignments

Experiments at 3rd E2SCMS **Soil respiration** In this experiment the consequences of an abrupt increase of slowly decomposable leaf litter is analyzed. One can think of this as if the litter had been somehow poisoned so that only extremely specialized bacteria or fungi are able to consume the litter. **Ocean Mixing** In this experiment the effect of an increased vertical mixing in the ocean mixing in the ocean is examined. **Ocean albedo** In this experiment the effect of an increased sea water albedo is examined. **Flat Earth** This experiment tests the effect of surface elevations, e.g. mountains, high plateaus etc., on the climate. Surface elevations are represented by the surface geopotential, which is seen by the resolved flow, and by surface parameters describing the sub grid-scale surface features. In this experiment the geopotential and the parameters describing the unresolved topography are set to zero, resulting in a "flat Earth" (though the surface roughness remains unchanged). **Increase of GHG concentration** This experiment explores the effects of an increase of CO2 concentration in the atmosphere, following a rate of 1% annually from pre-industrial levels.

The list of assignments is shown above. The answers of the students in form of their presentations can be found on our webpage[3] hosted in the ENES portal.

2.6 Deviations from the Description of Work (DoW)

NCAS and MPI-M swapped the order of execution of the schools from what was planned originally in the IS-ENES2 DoW, because it seemed appropriate to start the second school with the institute more experienced with international schools, i.e. MPI-M. NCAS planned and carried out the 3rd school.

3. Results

3.1 Announcement, Applications and Selection Process

The first announcement of the summer school was made in January 2016 via the dedicated ENES community and schools webpages (in the ENES portal). The announcement and copies of the call, and posters designed by NCAS, were sent out via the CLIMLIST mailing list, which is read in the community around the world. Furthermore, announcements were made via the IS-ENES2 and other well-known mailing lists as well as those in the participating institutions. The deadline for the

[3] https://verc.enes.org/community/schools/2nd-e2scms-1/lectures-and-suggested-reading/presentations

application was set to 21 March 2016 with an expected, allowable extension to 31 March 2016.

Applicants were required to submit a complete set of documents, which had to consist of:

I. A Letter of Motivation presenting the scientific motivation for the application, including information concerning the applicants' research interests and modelling skills.

II. A Curriculum Vitae (CV/Resume) including current occupation and contact information (e-mail and postal).

III. A description of the applicants' modelling experience: The applicant was asked to list computing knowledge (e.g. UNIX, use of supercomputers), experience with mathematical models, and statistical and data analysis tools.

IV. A reference letter: the referee was asked to e-mail the reference letter as pdf file directly to NCAS.

The selection process was executed jointly by BSC, NCAS and MPI-M staff, in cooperation with the ENES Board, the handling was done by NCAS. The applications were evaluated on a number of levels. First the applications were scored based upon how well they provided evidence of experience/knowledge with respect to each of the following essential criteria:

1. Interest in Earth system and climate research (preferably in a field invoking Earth system simulations or data from such simulations).
2. Acquaintance with high level programming languages like Fortran, C, or C++ (preferably applicants have some experience in the programming of model codes).
3. Familiarity with LINUX/Unix (basic knowledge of Unix systems and scripting).
4. Experience in working not only autonomously but also cooperatively.
5. Proficiency in English as a working language.

Second, the reference letter was ranked based upon how well it provided evidence of the applicant suitability.

Third, an overall score was given to the candidates overall suitability.

Fourth, assessors were asked to say if a candidate should be offered a place.

Scores and responses were aggregated into a recommendation list, which was discussed in a joint teleconference and a single list of candidates forwarded to the ENES Board for approval.

Based on this list, offer letters were sent by NCAS staff.

Accommodation and boarding grants (including the cost of the shared accommodation and meals) were also made available to candidates. As part of the application, candidates were offered to submit another document to provide evidence of need. All those applying for an accommodation and boarding grant that were accepted for the summer school, 8 in total, also received the grant.

Participants:

40 applications from around the world (15 countries, 5 non-European, 7 non-EU) were received for the 30 places available, and evaluated following the selection process described. 28 participants, of whom 12 were female, accepted the offer.

The participants (21 of whom were PhD students) were affiliated with 22 institutions, mostly located in Europe (21), of which 20 are in EU countries. 71% of the participants came from non-IS-ENES-partner institutions. Detailed information can be found in the table below; the actual list of participants is given in addendum.

Gender	Level of Study/ qualification	Country of employment /studies	Research Area / Job Title
Male	3rd year Phd	UK	Impact of water vapour and dust on variability of Sahara Heat Low
Male	1st year PhD	France	Evolution of the hydrological cycle in France during the 20th century
Male	1st year PhD	UK	Understanding the dynamical mechanisms through which the 11-yr solar cycle influences regional climates
Female	1st year PhD	Germany	Earth System Analysis
Female	1st year PhD	France	The diversity of ENSO under global warming
Male	2nd year PhD	Spain	Climate modelling
Male	1st year PhD	Spain	Arctic sea ice prediction and predictability
Male	2nd year PhD	Netherlands	Aerosol-cloud interaction
Female	1st year PhD	UK	[Palaeo]climate modelling
Male	Final year PhD	Saudi Arabia	Climate Modelling
Female	2nd year PhD	UK	Meteorology
Female	Post-doctoral r	Germany	Chemistry-Climate modelling
Female	3rd year PhD	Switzerland	Biogeochemistry of the Humboldt Current System
Female	1st year PhD	UK	Physical Oceanography
Male	1st year PhD	UK	Environmental Research
Female	Post-doctoral researcher	Germany	Physical Oceanographer
Male	1st year PhD	Spain	Impact of the Land Model Depth on climate and climate change simulations
Female	2nd year PhD	Germany	Climate Physics
Male	1st year PhD	France	Climate modelling
Female	Post-doctoral r	Germany	Paleoclimate
Male	1st year PhD	UK	Processes Determining Stratospheric Water Vapour
Female	Post-doctoral	UK	Climate Dynamics Scientist
Male	Post-doctoral	Finland	Arctic Research
Male	2nd year PhD	Finland	Global climate modelling
Male	Assistant professor	Netherlands	Hydroclimatology
Female	1st year PhD	Germany	Climate Impact and Decadal Prediction Research
Male	Post doctoral	Germany	Research Assistant in the field of Climate Modelling
Male	1st year PhD	Germany	Climate-Biogeosphere Interactions;

4. Perspectives

In view of the many PhD and post-doctoral positions in Europe that require skilled researchers on Earth's climate system modelling with a continuum spectrum of scientific and technical expertise, it would be highly desirable to aim for a new series of European Schools in the future. However, due to uncertainty about future funding, currently no direct follow-up school in this series is planned.

Material from the three ENES Earth System Modelling Schools is available on ENES portal and will be used in the future by organisers of schools in the individual countries.

An evaluation of the summer school took place in a common discussion towards the end of the event. From that, student expectations can be summarized as follows:

- The structure was very suitable for the school, though lectures and exercises should relate more to supporting the hypothesis formulation;
- It was good to present and discuss hypotheses without computer aid. Such techniques were recommended to be used more aggressively in following schools;
- Organizers were asked to consider a preparatory package to be distributed before the school. This package should contain reading suggestions and introductions to the tools used for data analysis during the school. This would offer the students a chance to start the school in a better-prepared fashion.

5. Addendum:

The Students:

Name	Institute
Nicholas Tyrrell	Finish Meteorological Institute (FMI), Helsinki, Finland
Stefanie Falk	Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany
Kira Rehfeld	Alfred-Wegener-Institute (AWI), Potsdam, Germany
Rosalind Haskins	National Oceanography Centre (NOCS), Southampton, UK
Saïd Qasmi	Centre National de la Recherché Scientifique / Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (CNRS-CERFACS), Toulouse, France
Netsanet Alamirew	University of Sussex, Brighton, UK
Rubén Cruz García	Barcelona Supercomputing Center (BSC), Barcelona, Spain
Marco de Bruine	Institute for Marine and Atmospheric Research (IMAU), Utrecht University, Utrecht, The Netherlands
Zhihong Zhuo	Institute of Meteorology, Free University of Berlin, Berlin, Germany
Sonja Molnos	Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany
Christian Stepanek	Alfred Wegener Institute (AWI) - Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany
Antonio Castaño Tierno	Universidad Complutense de Madrid, Madrid, Spain
Aude Carreric	Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), Toulouse, France
Muhammad M.A. Dogar	King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia
Matthew Brown	University of Oxford, Oxford, UK
Caroline Dunning	University of Reading, Reading, UK
Levke Caesar	Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany
Ana Franco	ETH Zurich, Zurich, Switzerland
Alexander Winkler	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Virna Loana Meccia	Max Planck Institute for Meteorology (MPI-M), Hamburg, Germany
Vikki Thompson	UK Met Office, Reading, UK
Jennifer Dentith	University of Leeds, Leeds, UK
Rémy Bonnet	Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (CERFACS), Toulouse, France

Samuel Hatfield	University of Oxford, Oxford, UK
Jacob Smith	Department of Applied Mathematics and Theoretical Physics (DAMTP), University of Cambridge, Cambridge, UK
Camilo A. Melo Aguilar	Universidad Complutense de Madrid, Madrid, Spain
Yijian Zeng	University of Twente, Enschede, The Netherlands
Filippo Xausa	University of Helsinki, Helsinki, Finland

The Lecturers:

Name	Institute
Bader, Jürgen	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Baker, Alexander	University of Reading, Reading, UK
Bozzo, Alessio	European Centre for Medium-Range Weather Forecast (ECMWF), Reading, UK
Fuckar, Neven	Barcelona Supercomputing Center (BSC), Barcelona, Spain
Galbraith, Eric	Universitat Autònoma de Barcelona (UAB), Barcelona, Spain
Hawkins, Ed	Dept. of Meteorology, University of Reading, Reading, UK
Heimann, Martin	Research Database Tuhat, University of Helsinki, Helsinki, Finland
Joussaume, Sylvie	Centre National de la Recherche Scientifique (CNRS), Paris, France
Jungclaus, Johann	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Kokkola, Harri	Finish Meteorological Institute (FMI), Helsinki, Finland
Marshall, David	Atmospheric, Oceanic and Planetary Physics (AOPP), University of Oxford, Oxford, UK
Notz, Dirk	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Petaejae, Tuukka	Research Database Tuhat, University of Helsinki, Helsinki, Finland
Pongratz, Julia	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Reick, Christian	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Solonen, Antti	Eniram (Company providing Energy Management Technology for Maritime Industry), Helsinki, Finland
Stemmler, Irene	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Vidale, Pier Luigi	University of Reading, Reading, UK

The Tutors:

Name	Institute
Evaldsson, Martin	Rossby Centre, Swedish Meteorological and Hydrological Institute (SMHI), Norrköping, Sweden
Gayler, Veronika	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Haak, Helmuth	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Koskhin, Sergey	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
O'Donnell, Declan	Finish Meteorological Institute (FMI), Helsinki, Finland
Serradell, Kim	Barcelona Supercomputing Center (BSC), Barcelona, Spain
Stemmler, Irene	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Uotila, Petteri (FMI)	Finish Meteorological Institute (FMI), Helsinki, Finland
Vannerie, Benoit	University of Reading, Reading, UK
Wieners, Kalle	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany

Administration:

Name	Institute
Weitz, Antje	Max-Planck-Institute for Meteorology (MPI-M), Hamburg, Germany
Sharpe, Steven	National Centre for Atmospheric Science, Reading, UK

The agenda:

E2SCMS3: 3rd European Earth System and Climate Modelling School

June 9 - 21 2016, Helsinki, Finland

Agenda v1.03, 2016-06-04

	Thursday June 9	Friday June 10	Saturday June 11	Sunday June 12	Monday June 13	Tuesday June 14	Wednesday June 15	Thursday June 16	Friday June 17	Saturday June 18	Sunday June 19	Monday June 20	Tuesday June 21
Time	Earth System Processes			Excursion		HadGEM2, EC-Earth and MPI-ESM components			Simulation analysis and interpretation		Day Off	Simulation analysis and interpretation	
09:00-10:00	Checkin: No later than 10 am please!	Atmospheric Physics: Jürgen Bader (MPI-M)	Cryosphere: Neven Fuckar (BSC)	Bus excursion to superstation Hyytiälä with overnight stay		Atmospheric composition and processes: Harri Kokkola (FMI)	Radiation and convection Alessio Bozzo (NCAS)	Ocean - salinity, nutrients, carbon Tatiana Ilyina (MPI-M)	Analysis of simulation results		At free disposition. A packed lunch will be available at breakfast. Dinner is available at the Hotelli AVA at 18:30	Analysis of simulation results	
10:00 - 10:30	Welcome, Introduction to facilities, overview Summer School												
10:30-11:00	Coffee Break					Coffee Break						Coffee Break	
11:00-12:30	Earth System Science and Coupled Models: Martin Heimann (MPI-BGC)	Ocean Physics: Dave Marshall (Univ. Oxford)	Ocean Biogeo-chemistry: Eric Galbraith (UAB)			Oceanic composition & Processes Johann Jungclaus (MPI-M)	Glaciers, Ice sheets, Sea ice: Dirk Notz (MPI-M)	Land - energy, water and carbon: Christian Reick (MPI-M)	Analysis of simulation results			Analysis of simulation results	
12:30-14:00	Lunch					Lunch						Lunch	
14:00-15:30	Introduction to simulation experiments Building Student teams	Energy and Water Cycles: Pier-Luigi Vidale (NCAS)	Land physics and biology: Julia Pongratz (MPI-M)			Finalizing hypotheses	Analysis of simulation results		Open Discussion: Students explain simulation results	Analysis of simulation results		Analysis of simulation results	Final student presentations
15:30-16:00	Coffee Break					Coffee Break						Coffee Break	
16:00-16:30	Use of workstations, remote access, and starting simulation experiments	Checking Simulation Experiments	Checking Simulation Experiments			Tutorial: From data to graphics, t.b.d.	Analysis of simulation results		Open Discussion continued. Only pencil and chalk allowed!	Analysis of simulation results		Analysis of simulation results	Final student presentations
16:30-17:00		Student teams start formulating hypotheses on system behavior in their simulation experiments	Hypotheses contd.										
17:00-17:30						Analysis of simulation results			Analysis of simulation results				Travel Time
17:30-18:00													
18:00-18:30	Travel Time					Travel Time						Travel Time	
18:30-19:30	Dinner for all at the Hotelli AVA		Dinner for those staying at the Hotelli AVA		Dinner for those staying at the Hotelli AVA	Dinner for all at the Hotelli AVA			Dinner for those staying at the Hotelli AVA			Dinner for those staying at the Hotelli AVA	Dinner including farewell ceremony (certificate hand over and poster award) – open end farewell party
19:30-21:00	Icebreaker and Poster session	After Dinner Talk by Sylvie Joussaume (IPSL)	Free time		Free time	After Dinner Talk "A brief history of climate change science" by Ed Hawkins (NCAS)	After Dinner Talk by Antti Solonen (Eniram, Helsinki)	After Dinner Talk Tuukka Petäjä (Univ. Helsinki)	Free time			Free time	
		Abbreviations:	BSC: Barcelona Supecomputing Center	FMI: Finnish Meteorological Institute, Helsinki	LSCE: Laboratoire des Sciences du Climat et de l'Environment, Gif sur Yvette, France	MPI-BGC: Max Planck Institute for Biogeochemistry, Jena	MPI-M: Max Planck Institute for Meteorology, Hamburg	NCAS: National Center for Atmospheric Science, Reading, UK	UAB: Universitat Autonoma de Barcelona				