# IS-ENES2

# 2nd PERIODIC REPORT
# Core Report


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**Project acronym:** **IS-ENES2**

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# Introduction to IS-ENES2

## Project abstract

IS-ENES2 is the second phase project of the distributed e-infrastructure of models, model data and metadata of the European Network for Earth System Modelling (ENES). This network gathers together the European modelling community working on understanding and predicting climate variability and change. ENES organizes and supports European contributions to international experiments used in assessments of the Intergovernmental Panel on Climate Change. This activity provides the predictions on which EU mitigation and adaptation policies are built.

IS-ENES2 further integrates the European climate modelling community, stimulates common developments of software for models and their environments, fosters the execution and exploitation of high-end simulations and supports the dissemination of model results to the climate research and impact communities. IS-ENES2 implements the ENES strategy published in 2012 by: extending its services on data from global to regional climate models, supporting metadata developments based on the FP7 METAFOR project, easing access to climate projections for studies on climate impact and preparing common high-resolution modelling experiments for the large European computing facilities. IS-ENES2 also underpins the community's efforts to prepare for the challenge of future exascale architectures.

IS-ENES2 combines expertise in climate modelling, computational science, data management and climate impacts. The central point of entry to IS-ENES2 services, the ENES Portal, integrates information on the European climate models and provides access to models and software environments needed to run and exploit model simulations, as well as to simulation data, metadata and processing utilities. Joint research activities improve the efficient use of high-performance computers and enhance services on models and data. Networking activities increase the cohesion of the European ESM community and advance a coordinated European Network for Earth System modelling.

**As per its DoW, IS-ENES2 has four main objectives** (in brackets relevant work packages and type of activity, see figure 1)**:**

- **To foster the integration of the European Climate and Earth system modelling community** by strengthening the ENES governance, further developing its strategy, especially with regards to model evaluation and model developments, stimulating interactions between global and regional climate modelling communities, and developing training (WP2/NA1)
- **To enhance the development of Earth System Models for the understanding of climate variability and change** by networking on future model developments required to improve model quality and use of future computing architectures, by stimulating common software developments and by providing a service on models and tools (WP3/NA2, WP4/NA3 and WP7/SA1)
- **To support high-end simulations enabling us to better understand and predict climate variations and change** by preparing for future exascale computing architectures (WP3/NA2), by preparing multi-model high resolution common experiments on the European PRACE high-performance computer facilities (WP9/JRA1), and by stimulating collaboration with ICT companies (WP6/NA5 & WP10/JRA2)

- **To facilitate the application of Earth system model simulations to better predict and understand the climate system and climate change impacts on society** by enhancing the dissemination of model results from both global and regional model experiments (WP8/SA2), by developing an interface dedicated to the climate impact community and improving the quality of information on simulations through metadata developments and guidance to users (WP5/NA4 & WP11/JRA3) and by enhancing interaction between the climate modelling activity and users from companies and the emerging climate services (WP6/NA5).

IS-ENES2 aims at serving the needs of the climate modelling community as well as the needs of communities using model results to study the impacts of climate change and develop climate services.

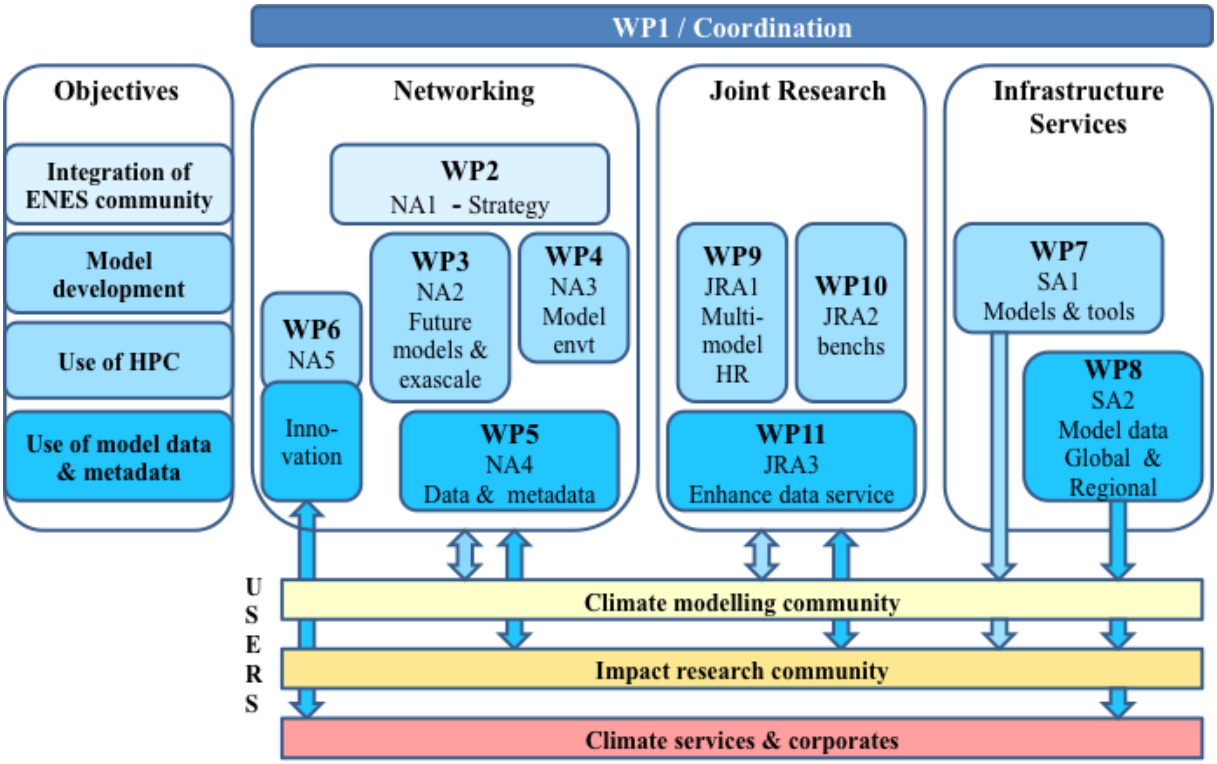



Fig.1: Organisation of IS-ENES (type of activities, thematic grouping into Work Packages) with respect to the project's objectives and relations with user communities.

# Project objectives for the period

The second period of IS-ENES2 has been devoted to the following main objectives:

**Sustain and enhance service activities on models and on model data:**

- On models and tools (WP7/SA1): continue the service on models and tools and improve information on the service based on the outcome of the first internal review and the mid-term review; document the NEMO configuration at 0.25° to be used in high-resolution simulations.
- On model data and metadata (WP8/SA2): integrate new services for the metadata repository, provide access to results of a larger number of CORDEX experiments for Europe and Africa, continue the help desk services for data users (CMIP5 and CORDEX) and data node providers, and deploy more services on the climate4impact portal.

**Develop network activity with a specific focus on:**

- Strategy issues: implement a data task force to complement the HPC task force and pursue the preparation of long-term infrastructure strategy (WP2/NA1)
- Community building: further develop and maintain the ENES portal and prepare the 3rd ENES summer school (WP2/NA1)
- Strengthen the networking around radiation code and cloud simulator software, and analyse possible convergence of codes (WP3/NA2)
- Enhance sharing of experience around environment tools for climate models, such as configuration management (WP4/NA3)
- Prepare for future HPC architectures: with work on model performance through the analyses of kernels in atmosphere and ocean codes (WP3/NA2), with technology tracking on exascale (WP3/NA2) and by collaborating with ICT industry (WP6/NA5)
- Data and metadata standards (WP5/NA4): collaborate at a global scale to prepare CMIP6 specifications and standards, refine requirements for quality control of data, and extend the Common Information Model (CIM) used for metadata to regionally downscaled model results (WP6/NA5)
- Network with a range of users from the climate impact community as well as climate service providers (WP5/NA4 and WP6/NA5)

**Develop joint research activity with a specific focus on:**

- High-end experiments (WP9/JRA1): prepare multi-model, multi-member high resolution experiments, improve performance through coupler and I/O, improve workflow tools for multi-model simulations
- Benchmarking (WP10/JRA2): develop coupled model benchmarks and prepare benchmarking experiments on different coupling approaches
- Improving data services (WP11/JRA3): maintain and improve software tools for the international Earth System Grid Federation (ESGF) model results data base, maintain and develop software tools for the metadata Common Information Model (CIM), enhance climate4impact portal functions with a particular focus on implementing downscaling tools and calculations of climate indices, and on developing monitoring tools for ESGF.

# Main results for the second period

Results presented in the following descriptions of each work package (WP) activity show that the project has kept its main schedule. Some reorganization took place, with activities being advanced or delayed, due both to external factors and internal developments, as detailed in WP descriptions below. None of the changes affected nevertheless the overall course of the project.

Several key background issues have impacted the activities of IS-ENES2 during this period.

- First, the international database ESGF had to be shut down for approximately six months due to a security breech. The situation required a complete revision of software heavily involving European experts. IS-ENES2 could however maintain a minimum of service due to their hosting of the IPCC database and the existence of replica.
- IS-ENES2 has used the opportunity of the coordination of the new international CMIP6 coordinated experiments to gain wider impact in the community. Several of our activities have focused on developing updated plans and versions of key software stacks for use by the international community.
- The new Copernicus Climate Change Service has also been set during this second period. This has been an opportunity to implement our objective to link IS-ENES2 services to climate services, several partners of IS-ENES2 have been involved in the various scoping workshops organised by ECMWF to better define the outline of the service and organisation. It contributed to the decision of ECMWF to broker on ESGF to access climate projections. .
- Following the EC policy to support applications of high-performance computing, IS-ENES2 has been instrumental in developing a successful Centre of Excellence for climate and weather modelling. This COE, called ESiWACE, benefits from and interacts with IS-ENES2, going at the same time beyond IS-ENES2 with regards to application development and with the preparation to future computing architectures, in agreement with the ENES infrastructure strategy.

**Taking these background changes into account, main achievements of IS-ENES2 during its second period, described according to the project main objectives, are:**

**To foster the integration of the European Climate and Earth system modelling community**

- Consolidation of the international role of IS-ENES has been obtained by having own representatives among the international ESGF governance members, at the Steering, Executive and working teams levels. IS-ENES partners have also been very active within the WGCM Infrastructure Panel to prepare guidelines for CMIP6 (WP2/NA1, WP5/NA4, WP11/JRA3).
- A new ENES data task force has been set to complement the HPC task force. This data task force aims at advising on all matters related to data, especially with regards to international activities (ESGF and ES-DOC), as well as with European activities (e.g. climate4impact portal). (WP2/NA1).
- Integration of the climate community around HPC has been reinforced with the successful proposal for a Centre of Excellence ESiWACE. This has been an opportunity to further integrate with the numerical weather prediction community, which shares many of the climate modelling HPC issues, as well as with some industrial collaborators. A common workshop was organised (WP2/NA1, WP6/NA5 with other WP on HPC).
- Preparation of the long-term sustainability of the climate modelling infrastructure has continued with the preparation of an ESFRI proposal CliM-ERI (Earth's climate system modelling European research infrastructure). Submission of this proposal had, however, to be postponed.

- The IS-ENES services have been better emphasized by a major revision of the ENES portal, following advice from both the internal reviews and the mid-term review (WP2/NA1, WP7/SA1, WP8/SA2).

**To enhance the development of Earth System Models for the understanding of climate variability and change**

- A best practice guide on Configuration Management has been developed, based on inputs from 32 relevant institutions (currently in draft) (WP4/NA3).
- More efficient diagnostics to simulate cloud satellite data have been shared and preliminary work on model convergence started (WP3/NA2).
- Guidelines for common governance on model coupling have been established and will serve in ESiWACE (WP4/NA3). The benchmark suite to evaluate coupling strategies has been further defined and its implementation has started (WP10/JRA2).
- Services on models and environment tools (WP7/SA1) have been continued.

**To support high-end simulations enabling us to better understand and predict climate variations and change**

- A suite of benchmarks for coupled models has been developed, tested and made available from web (WP10/JRA2).
- High-resolution experiments have been designed and prepared, and model performance improved through inclusion of the OASIS3-MCT version of the coupler and, at least for some models, inclusion of parallel I/O servers (WP9/JRA1).
- Through the HPC task force, a project has been prepared and will be proposed to PRACE to perform high-end experiments within CMIP6 (WP2/NA1 and WP9/JRA1).

**To facilitate the application of Earth system model simulations to better predict and understand the climate system and climate change impacts on society**

- IS-ENES2 successfully coped with the ESGF six-month-long downtime by maintaining a service with a reduced set of data. Moreover, the Europeans have been very active with the US colleagues in solving the issue and allowing ESGF to start again.
- IS-ENES2 teams have also continued to play a critical role in developing ESGF data nodes for CORDEX results for the Euro-CORDEX and Africa-CORDEX domains (WP11/JRA4 and WP8/SA2) as well as for downscaling products. Rules on how to interact with the CORDEX Scientific Advisory team have been established.
- IS-ENES2 is also strongly involved in the development of the metadata services, standards and interfaces in collaboration with US (WP11/JRA3). An updated version of the CIM has been developed for CMIP6, improved tools and services to access CIM have been implemented (WP11/JRA3). The networking activities have been influential in steering the development of metadata technologies that will make the provision of meta-data for CMIP6 more efficient (WP4/NA3).
- The climate4impact portal, aiming to ease access to ESGF model data for the climate impact community, has been upgraded to include access to downscaled information and compute climate indices (WP11/JRA3 and WP5/NA4).

# Work progress and achievements during the period

Synthetic presentation of main results and assessment of next steps and, for some cases, deviations

| | Positive aspects | *Deviations* / next steps |
|---|---|---|
| **Integration**<br><br>NA1 | **Governance:** Newly established ENES data task force | Upcoming revision of ENES scope and MoU |
| | **Plans for a sustainable infrastructure (not initially planned):** Successfully launched Centre of Excellence ESiWACE with the weather community. Further discussion on sustainability and possibility for an ESFRI. | Plans for sustainability to be discussed in the frame of the planned mid-term update of the foresight document<br><br>In mid-term, need to set the organisation to continue common activities beyond IS-ENES2. |
| | **Foresight**: drafted paper on the strategy for model evaluation infrastructure, which contributes to the international CMIP6 preparation. | Paper yet to be submitted |
| | **ENES portal:** strong revision after mid-term review | |
| **MODELS And Environment tools**<br><br>NA2, NA3 SA1, JRA2 | **Service on climate model**: continued level 1 and level 2 services<br>Positive feedbacks from internal reviews | |
| | Continued services on OASIS, NEMO and CDO | |
| | **Virtual workshop on model configuration management tools** | Best practice guide on Configuration Management will be completed in RP3. |
| | **Networking on common radiation code and diagnostics** | *Delayed due to departure of key staff in October 2015. Position has been filled only in April 2016.* |
| | **Coupling methodologies**<br>Guidelines elaborated for a common governance and evaluation suite for benchmarking different coupling methodologies issued. | More general governance rules on common software still to be elaborated. |

| | | |
|---|---|---|
| **HPC**<br><br>NA1, NA2, NA5, JRA1, JRA2 | **Improved performance of codes:** inclusion of OASIS3-MCT, I/O servers. Analyses of performance key bottlenecks for NEMO. | |
| | **Preparation of high-end experiments** started with performance analyses and ensemble submission software. Plans for experiments developed. | Multi-model multi-member experiments still to be tested. |
| | **Preparation of a common PRACE proposal** for high-end experiments within CMIP6 | Decision pending in view of upcoming PRACE2. |
| | **First implementation of coupling technology benchmarks delivered** | |

| | | |
|---|---|---|
| **Data and metadata**<br><br>NA4, NA5<br>SA2<br>JRA3 | **ESGF:** European representatives, playing a key role within IS-ENES2, placed in the newly established international governance.<br>Strong involvement of European experts for the restart of ESGF and the preparation of CMIP6 within the WIP. | During the last year of the project many development made during RP2 need to become a service activity. |
| | **CORDEX data nodes**:<br>Key role of IS-ENES2 in implementing CORDEX data in ESGF.<br>Leadership role recognised by WCRP.<br>Rules on how to interact with CORDEX Scientific Advisory Team established. | Enhance CORDEX data accessibility: Africa-CORDEX, CORDEX-ESD. |
| | **Metadata standard:** update of CIM in preparation of CMIP6. Extended standards for downscaled information. | Finalize CMIP6 developments and establish them as services. |
| | **Climate4impact portal**: implementation of climate indices and downscaled products.<br>Development and execution of 3 master class trainings on portal use. | |

## WP2 /NA1: ENES strategy

| Work Package Number | *WP2/NA1* | | Start Date or Starting Event | | | | | Month 1 | |
|---|---|---|---|---|---|---|---|---|---|
| **Work Package Title** | **ENES strategy** | | | | | | | | |
| **Activity Type** | *COORD* | | | | | | | | |
| **Participant Number** | **1** | **6** | **10** | **5** | **3** | **4** | **14** | **22** | **9** |
| **Participant Short Name** | **CNRS-IPSL** | **MetO** | **MPG** | **UREAD-NCAS** | **CERFACS** | **DKRZ** | **UIB** | **DLR** | **KNMI** |

**Summary of progress of the work package:**

WP2/NA1 aims at strengthening the integration of the ENES community. It includes three levels of action: strengthening the governance of ENES, further developing the ENES strategy, and supporting community building.

**Task 1: ENES governance**

During RP2, major advances have been performed concerning data governance at both European and international levels.

- A Data Task Force has been created to advise the ENES Board on issues related with data and metadata. At the international level, governance has been put in place for ESGF with IS-ENES2 represented at the Steering (1 member) and Executive levels (3 members). Moreover, Europe leads or co-leads half of the international working groups (16), which develop and implement ESGF. IS-ENES2 has also provided intellectual leadership and played a key role in the evolution of the metadata standards prepared by ES-DOC as well as in the elaboration of recommendations for CMIP6 prepared by the WGCM Infrastructure Panel (WIP).
- The HPC task force (HPCTF) continues to provide the major route for community interaction around HPC, within the community and with PRACE. IS-ENES2 played a key role to trigger the successful proposal of a Centre of Excellence for Weather and Climate bringing together the weather and ENES communities. The new centre extends from, and complements, IS-ENES2 in order to improve the scalability, usability, and exploitability of relevant applications on HPC. Concerning PRACE, a recent initiative has been the preparation of a plan for targeted access for high-end experiments within the next CMIP6 international coordinated experiments. Following feedback with the PRACE Council, a project is under preparation and discussed within the HPCTF.
- In order to prepare for a sustained infrastructure in climate modelling, a proposal for an ESFRI has been prepared, CliM-ERI for the "Earth's climate system modelling European Research Infrastructure", involving the ENES Board as well as the ENES task force on HPC and a precursor for a data task force. However, this proposal had to be postponed due to limited readiness of some countries to support the project.

**Task 2: European Climate Community Strategy**

During RP2, a white paper has been prepared on "infrastructural needs for routine ESM evaluation in CMIP6". This paper, elaborated internationally with the US in order to help prepare the required infrastructure for the next phase of CMIP, was submitted to BAMS (mo 24) – but alongside positive reviews one critical review led us to a revised publication strategy. Accordingly, a new version is under preparation for the European open-access journal ESD and should be resubmitted in coming months. This white paper will contribute to mid-term update of the ENES infrastructure strategy due in RP3 (and for which preparation has begun).

**Task 3: Climate modelling community building**

**Summer School**
The 3rd European Earth System and Climate Modelling school has been prepared and will be held in Helsinki in June 2016, 9-21.

**ENES Portal**
Following recommendations at the mid-term review, the ENES portal (https://portal.enes.org) has been upgraded with the objectives to improve the visibility of the services and ease its use. In the months after the upgrade, the statistics show an impressive increase of the portal usage, suggesting the success of the upgrade. Monthly unique visitors increase from about 3000 before the upgrade up to 12000 in November 2015, stabilizing since then at around 9000 unique visitors per months.

**Significant results:**

**Task 1:**
- Preparation of the Centre of Excellence ESiWACE
- Participation to ESGF Steering and Executive Committees
- Definition of the data task force terms of reference and start of the data task force in April 2015.
- HPC Task Force has regularly interacted (9 telcos or meetings) to prepare a request to PRACE for CMIP6.
- Preparation of the 4th ENES HPC workshop in collaboration with ESiWACE.

**Task 2:**
- A first version of D2.3 has been prepared as a paper submitted to BAMS (mo 24). A revised version is nearly finalised and will serve as D2.3.

**Task 3:**
- Preparation of the 3rd ENES Summer School to be held in June 2016: Practical organisation, elaboration of the program, call for applications, selection of students.
- A major upgrade of the portal has been performed after the mid-term review.

**Deviations from Annex I (DoW):**

**D2.1**, a draft version of the update of ENES governance rules has been prepared. It includes terms of reference of the HPC and data task forces already in place. The final version has been delayed since it still needs an update of the initial MOU and some further discussion on the composition of the ENES Board. It does not prevent ENES to work and the ENES Board was enlarged to all main European global modelling groups to discuss the CLIMERI proposal. Plan is to further discuss the ENES governance at the foresight workshop planned in October 2016.

**D2. 3** a draft version has been produced first as an international paper submitted to BAMS and now as a draft paper for ESD. Main ideas are in place and will be implemented for CMIP6. It is important that D2.3 is a well-adopted international paper that can be widely distributed to serve the update of the infrastructure strategy due in RP3. New plan is to submit the paper in month 39.

**Reasons for failing to achieve critical objectives and/or not being on schedule**

Delays of **D2.1** and **D2.3**, see above. These delays do not impact the project.

**Use of resources:**

**CNRS-IPSL, 19.26 PM,** co-leads WP2. CNRS-IPSL with the ENES scientific officer chairs the ENES Board and is involved in the international governance and in the HPC and Data Task Forces.

**MetO, 0.7 PM,** participates to the HPC task force, the ENES Board and prepares governance rules for common software.

**MPG, 0 PM,** participates to the HPC task force, the ENES Board and contributes to the organisation of the 3rd ENES summer school.

**UREAD-NCAS, 5.1 PM**, leads WP2**,** participates to the HPC task force, the ENES Board, leads the data task force. UREAD-NCAS is involved in the international governance for ESGF, ES-DOC as well as WIP. It leads the preparation of the 3rd ENES summer school.

**CERFACS, 1.5 PM**, leads the HPC Task force and collaborates on preparing the governance on software.

**DKRZ, 3.7 PM**, is in charge of maintaining and upgrading the ENES Portal. DKRZ is also involved in the HPC and data task forces. DKRZ has been strongly involved in the preparation of ESiWACE center of excellence that it coordinates.

**UiB, 4 PM**, has contributed to the elaboration of the white paper on model evaluation infrastructure strategy.

**DLR, 0.78 PM**, leads the paper on infrastructural needs for model evaluation. V. Eyring as chair of the CMIP Panel, ensures an international dimension to this activity and its insertion in the preparation of CMIP6.

**KNMI, 0 PM**, has not contributed to RP2.

**Corrective actions -** *none*

## WP3-NA2 / Towards next generation models

| Work Package Number | *WP3/NA2* | | Start Date or Starting Event | | | | | Month 1 | |
|---|---|---|---|---|---|---|---|---|---|
| Work Package Title | Towards next generation models | | | | | | | | |
| Activity Type | *COORD* | | | | | | | | |
| Participant Number | 4 | 10 | 5 | 2 | 1 | 12 | 7 | 16 | 6 |
| Participant Short Name | CMCC | MPG | UREAD-NCAS | DKRZ | CNRS-IPSL | UNIMAN | STFC | BSC | MET-O |

**Summary of progress of the work package:**

WP3/NA2 is devoted to prepare the climate community for exascale and better connect those working on climate models by establishing some code convergence and shared understanding of divergent codes.

The second reporting period started the implementation of the common radiation tool and related interfaces. Moreover, the optimization of the COSP computational performance has been carried out. Regarding the computational code convergence, some activities have been performed on the NEMO European ocean model and the ICON atmospheric model in order to improve their scalability, while the EC-EARTH ESM has been analysed using the DIMEMAS tool.
The technology tracking activity has been continued through the definition of future strategies for the re-design of analysed models to better exploit new architectures.
Finally, the workshop on Coupling/Framework strategies has been organized to analyse the impact of new coupling strategies for climate models at exascale.

**Details for each task:**

**Task 1: Building a community using common radiation tools**
Task 1 is devoted to putting in place a community working on developing a common radiation library, as well as developing and extending the existing community work on optimising the observation system simulators.
During the second period, the Edwards-Slingo radiation code (renamed SOCRATES) has been turned into an open source module. The interface to the code has been modified taking into account the standardization process defined during the first period. In the third period, we will work on the standardization of the IPSL and MPI-M radiation code APIs along the lines that were applied for SOCRATES, and the modularisation of the codes.
The COSP simulator has been optimized and the activity has been reported in a working document. Moreover, a contribution to the major restructuring of the COSP interface has been provided, testing the new version in the stand-alone mode as part of the Unified Model. Finally, a contribution to the definition of the COSP diagnostics proposal for the Climate Model Intercomparison Project phase 6 (CMIP6) has been done.

**Task 2: Developing convergent model codes**
Task 2 is devoted to the code convergence. During the second period, the activity has focused on the improvement of scalability of the NEMO ocean model and of the ICON atmospheric model. Starting from the analysis of these models performed during the first period, some of the main bottlenecks to the scalability have been addressed. In details, the implementation of the north fold algorithm of NEMO has been optimized and results have been reported in a working document. Some memory issues of the ICON model, preventing scaling to 1Mcores have been analysed, identified and fixed. Moreover, the analysis of the programming languages used by the European and non-European ESMs has been completed and reported in a working document.

Finally, the analysis of EC-Earth 3.2beta version using BSC performance tools and DIMEMAS simulator is in progress.

**Task 3: Technology tracking**

Task 3 is devoted to the technology tracking. Starting from the main outcomes of the workshop on exascale technology organized in the first period, a new document describing how the NEMO model could be re-designed to efficiently exploit the new architectures has been produced. The document will be integrated with the ICON re-design strategy during the last period.

The analysis of the performance improvement derived from the introduction of a second level of parallelization in NEMO (using the mini-app approach) has been performed and results have been collected in a paper accepted for publication in the International Journal of High Performance Computing Applications (Epicoco et al., 2016).

An international workshop on coupling strategies has been organized in Manchester in April 2015 (**MS3.2**). The main topics have been technologies, benchmarking, and interoperability of coupling systems towards the exascale era. The main outcomes of the workshop have appeared in BAMS in March 2016 (http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-15-00239.1)..

**Significant results:**

**Task 1:**

- Computational performance improvement achieved on the CloudSat simulator software. Delivery of the document "Progress report on COSP optimisations v2".

**Task 2:**

- NEMO performance improvement due to the optimization of the NEMO north fold algorithm. Delivery of the document “NEMO north fold optimization”
- List of programming languages used by the community. Delivery of the document “Earth System Models programming languages”

**Task 3**:

- International workshop on Coupling Technologies for Earth System Models in April 2015 (**MS3.2**) with main outcomes published in BAMS (Valcke et al., 2016) http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-15-00239.1
- Paper on “Hybridisation Strategies and Data Structures for the NEMO Ocean Model” in IJHPC, accepted for publication

**Deviations from Annex I (DoW):**

The milestone **MS3.3** “Workshop on Model Structure, Code Evaluation” has been delayed from month 24 (March 2015) to Autumn 2017. This has been to take advantage of other activities going on in Europe, in particular to be timed to exploit the possibility of input from two major European activities on dynamical cores which have been developing innovative new techniques for domain specific languages for automating some parts of the model stack. This has meant the delay of D3.2.

The milestone **MS3.4** “Workshop on European Radiative Transfer Library” has been delayed from month 30 (September 2015) to month 39 (June 2016) due to staff departure. It will be organised with the MetOffice, CNRS-IPSL, MPG and, as external partner, CSCS. It will not have any delaying impact on other activities of DoW.

The milestone **MS3.5** “Workshop on Convergence” will be amalgamated with milestone M3.3.

The deliverable **D3.2** “Report on strategies for developing convergent model codes” has been delayed from month 36 (March 2016) to follow the workshop delayed in **MS3.3**, but with no impact on other

activities of DoW. We believe this delay will be of significant benefit to the goal of getting community engagement in code convergence.

**Reasons for failing to achieve critical objectives and/or not being on schedule**

No critical deviation. Delays are explained above.

**Use of resources:**

**CMCC: 8.01 PM**, leads the WP by participating to project meetings and by scheduling the activities. In task 2.2 CMCC optimized the NEMO north fold algorithm implementation achieving a reduction of the execution time of about 25% on 16Kcores of a BG/Q system. In task 3.1, CMCC produced a document describing how the NEMO model could be re-designed to efficiently exploit the new architectures. Finally, in task 3.2 CMCC, in collaboration with STFC, analysed the introduction of a hybrid parallel strategy in NEMO (using mini-app approach). Results have been collected in a paper accepted for publication in the IJHPC. The number of person months is higher than initially planned because figures with a lower monthly rate have been employed.

**MPG: 0 PM**. MPG will start the development of the library in the third period due to the lack of staff. MPG organized two meetings with other ICON partners to define the development work plan, also considering radiative code development. See below.

**UREAD-NCAS: 5.8 PM.** In task 2.1, NCAS performed a preliminary analysis of three atmospheric models (HiRAM, OpenIFS and HadGEM3A) and produced a poster (Wilson, 2015). Due to the delay in completing M3.3 and D2.2, most of the NCAS spend in this work package is held over to RP3.

**DKRZ: 2 PM.** In task 2.2, DKRZ refactored part of the ICON code to fix memory issues preventing scaling up to 1Mcores and to improve performance portability. DKRZ plans to reallocate 3 pm from this WP to WP11/JRA3 (see section on budget reallocations). However, the activities planned for this WP will benefit from synergies with other projects leading to less effort to be reported to IS-ENES2.

**CNRS-IPSL: 1 PM.** In task 1.1, CNRS-IPSL performed radiative computations for a few test cases to quantify and analyse the change of the greenhouse effect when changing the CO2 and water vapour concentration. These reference computations will allow us to specify the required accuracy for the common radiative code. During the next 11 month, a post-doc will implement the MPG radiative code with the new interface within the IPSL atmospheric model, LMDZ.

**UNIMAN: 7 PM.** In task 3.3, UNIMAN, in collaboration with STFC, organized the 3rd International Coupling Workshop, held in Manchester in April 2015 and contributed to the BAMS paper summarizing the workshop, which has been published in March 2016. With the agreement of the project officer, UNIMAN used some of their IS-ENES2 funding to partly support the living costs of a PhD student from September/October 2015 until the end of the project rather than on pms. This affects the final total person months claimed for this work package but not the activity.

**STFC: 1.81 PM**. In task 3.2, STFC, in collaboration with CMCC, performed an analysis of hybrid parallel strategy on NEMO (using mini-app approach). Results have been collected in a paper accepted for publication in the IJHPC. In task 3.3, STFC, in collaboration with UNIMAN, organized the 3rd International Coupling Workshop, held in Manchester on April 2015.

**BSC: 4.17 PM**, completed the analysis of programming languages used by the European and non-European ESMs. Analysis of EC-Earth 3.2beta using BSC performance tools and DIMEMAS simulator is in progress.

**MetO: 4.2 pm**, has contributed significantly to task 1.1 through the re-design and coding of a new

interface for the SOCRATES radiation code (as used in the UM) influenced by the discussions with the other partners of the task. In task 1.2, MetO contributed to (i) the optimization of COSP v1.3.2 achieving a reduction of 32% in computing time and an acceptable degree of accuracy of the output, (ii) the development of COSP v2 and (iii) the definition of the COSP diagnostics proposal for the Climate Model Intercomparison Project phase 6 (CMIP6).

**Corrective actions***: None.*

# WP4/NA3: Earth System Modelling Environments

| Work Package Number | *WP4/NA3* | | Start Date or Starting Event | | | | Month 1 |
|---|---|---|---|---|---|---|---|
| Work Package Title | Earth System Modelling Environments | | | | | | |
| Activity Type | *COORD* | | | | | | |
| Participant Number | 10 | 1 | 2 | 3 | 4 | 6 | 22 |
| Participant Short Name | MPG | CNRS/ IPSL | DKRZ | CERFACS | CMCC | MetO | UiB |

**Summary of progress of the work package:**

The objective of this work package is to provide networking activities to increase the pace of climate science employing modelling by sharing best practice in software environments for Earth System Models and encouraging more sharing of selected codes within the climate community.

A document (WP4/ Earth System Modelling Environments: "Set of recommendations from the workshops"**)** has been produced providing draft recommendations from the initial workshops in this work-package[1]. The paper covers Configuration Management, Workflow and Meta-data creation.

**Details for each task:**

**Task 1: Workflow solutions, including seasonal to decadal (S2D) climate prediction systems.**

The first workshop on workflow solutions organised by DKRZ and MPG helped identify useful development activities for Cylc to be undertaken in the WP9/JRA1.
In Reporting Period 2, no further activity was planned, apart from starting to prepare the second workshop planned in Lisbon, Portugal in September 27-29, 2016. This workshop will focus the discussion on available post processing solutions in the community and how they are integrated into workflows. Also, it will strongly interact with workflow activities in other projects like EUDAT2020 and ESiWACE.
Furthermore, not planned, but useful for other reasons, the paper mentioned above was produced. Such recommendations were not the target of this first round of workshops and not indicated to the participants as aim of the workshops. Hence, the recommendations are the sole conclusions of the authors and not those of any part of the participants. The next workshop will be an opportunity to re-discuss these recommendations and, taking into account the comments of the mid-term review, it will ensure there is an emphasis on providing community recommendations based on current best practice. This is indeed important since, as the paper states:
"*The next CMIP will pose serious challenges to the community, not only in scientific, but also in organizational and technical terms. ENES is currently coordinating requirements and governance suggestions for submission to the organizing bodies for CMIP6, but more engagement with, and contributions from, the community are always welcome. At the same time, the community institutions need to understand the fact that more technical expertise and resources within the institutions, closely linked to the CMIP6 organizing bodies and their activities, will be necessary to cope with this challenge*."

**Task 2: Configuration Management Tools**
The section of the document summarising the first set of workshops on Configuration Management has been used to develop, with a broad set of representatives from the community, a "Best Practice Guide on Configuration Management". This document[2] will be finalised in the final reporting period but currently has input and support from representatives from 32 institutions. The document was produced as part of a virtual workshop containing a small number of complementary papers (**MS4.5**).

1 https://verc.enes.org/ISENES2/documents/na3-documents/wp4-esm-environments-recommendations/view

2 current draft available at https://verc.enes.org/ISENES2/documents/na3-documents/cm-documents

The networking activity has also supported the evaluation of FCM by CNRS-IPSL who provided a paper to the virtual workshop.

**Task 3: Metadata creation and usage**

As planned in DoW, the second workshop on metadata is planned for the next reporting period. During RP2, MetO has continued to engage with development of meta-data schema and technologies within IS-ENES2, the ES-DOC project and with the wider community preparing for the CMIP6 exercise (http://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6) to ensure that it is possible to integrate meta-data collection with local working practices and tooling for this key international activity. CNRS-IPSL supported MetO making sure the outcome of the work here would be influential within the ES-DOC activity. This will lead to a step change in efficiency at CMIP6. Significant tasks have included reviewing and monitoring of the ES-DOC project's python API for producing Common Information Model (CIM) metadata documents and providing regular feedback to guide the subsequent development of this API. This close working interaction with ES-DOC, including CNRS-IPSL as ES-DOC technical lead, and UREAD as semantic lead, has continued with the development of enhanced CIM schemas that will be used for CMIP6, and a leading role in defining the plan for the end-to-end testing of the ES-DOC tooling (CIM, pyesdoc API and metadata portal). Further, the networking activity has influenced the way certain meta-data will be stored for CMIP6. In CMIP5, data that needed to be corrected was stored in file headers making it hard to correct. A methodology has been devised to point from the headers to a meta-data catalogue, which is far more efficient to change.

**Task 4: Governance of a community coupler**

The draft paper on the governance for the coupler was delivered in this RP2 (**MS4.3**) as well as the associated deliverable **D4.3** presenting the governance proposed. Furthermore, the "3rd Workshop on Coupling Technologies for Earth System Models" in Manchester was held in April 2015. A "Working Session II – Future Issues: interoperability, sharing of models/infrastructure, governance, exascale" was co-led by CERFACS, and the results of the user survey on OASIS governance (related to MS43 and D4.3) were presented.

**Significant results:**

**Task 1:**

- Paper "Earth System Modelling Environments: Set of recommendations from the workshops" co-produced
- The **D4.2** report on the initial workshop on workflow solutions has been produced in month 23
- Strong Liaison to related activities in other projects like EUDAT2020 and ESiWACE
- Provided information to development activities within WP9

**Task 2:**

- Second Workshop on Configuration Management Tools prepared and carried out as virtual workshop with 9 papers on March 31st 2016 (**MS4.5**).
- Paper "*Earth System Modelling Environments: Set of recommendations from the workshops*" coproduced and developed into a best-practice document on configuration management with widespread user support.

**Task 3:**

- Started to plan second Workshop on meta-data creation and usage.
- Input to ES-DOC and meta-data developments to improve efficiency for CMIP6.
- Paper "Earth System Modelling Environments: Set of recommendations from the workshops" co-produced

**Task 4:**

- Governance paper **D4.3** delivered based on the draft governance (**MS4.3)**
- Workshop on coupling technologies co-led with WP3/NA2

**Deviations from Annex I (DoW):**

Following mid-term Review recommendations a paper providing draft recommendations from the initial workshops has been produced.

**Reasons for failing to achieve critical objectives and/or not being on schedule**: None

**Use of resources:**

**MPG: 3.3 PM,** MPG leads WP4/NA3. MPG contributes to the preparation of the next workshop on workflow and has co-organised the virtual workshop on configuration management. MPG contributed to the writing of the paper containing recommendations from the workshops. MPG has provided advice on governance issue.

**MetO: 0.2 PM,** MetO co-leads WP4/NA3. MetO lead and prepared the second workshop on configuration management. They contributed to the writing of the paper containing recommendations from the workshops. MetO also supported FCM evaluation, worked with other work packages to ensure metadata developments meet the modelling community needs for CMIP6 and contributed to discussions on governance issue. MetO also supported networking on workflows commenting on a comparative evaluation of Cylc and Autosubmit and identifying development opportunities to support the aims of WP9.

**CNRS-IPSL: 3.56 PM,** CNRS-IPSL worked on the FCM evaluation, and participated in the virtual workshop. CNRS-IPSL also worked to consolidate links with ES-DOC.

**DKRZ: 2.3 PM,** Some evaluation work of the workshop on metadata generation (1.1 PM) and workshop participation are reported for RP2.

**CERFACS: 4.9 PM**, co-organised the third international workshop on coupling technologies, and led the discussion about the coupler governance.

**CMCC**: **0 PM**, no activity during this period.

**UiB: 0.56 PM,** have contributed to Task 3 of the WP by implementing the required CMIP6 meta-data handling into the NorESM workflow. Further, responding to discussions from first meta-data workshop, UiB have further consolidated and optimized the Norwegian national data archive system and data annotation was improved to agree with CMIP5 standards and exposed to the search interfaces of the ESGF portals.

**Corrective actions:** None

## WP5/NA4: Data Networking

| Work Package Number | *WP5/NA4* | | Start Date or Starting Event | | | | Month 1 |
|---|---|---|---|---|---|---|---|
| **Work Package Title** | **Data Networking** | | | | | | |
| **Activity Type** | *COORD* | | | | | | |
| **Participant Number** | **1** | **2** | **3** | **4** | **7** | **8** | **9** | **11** |
| **Participant Short Name** | **CNRS-IPSL** | **DKRZ** | **CER-FACS** | **CMCC** | **STFC** | **SMHI** | **KNMI** | **CSAG** |
| **Participant Number** | **12** | **14** | **17** | **19** | **21** | | | |
| **Participant Short Name** | **UNI-MAN** | **WU** | **UC** | **DMI** | **MF-CNRM** | | | |

**Summary of progress of the work package:**

Despite the security problems that lead to the ESGF shutdown between July 2015 and March 2016, significant progress has been achieved in the work package. The shutdown, however, impacted some deliverables and milestones with some delays, which will not affect other tasks and work packages. Continuous international collaboration on the ESGF software stack developments were pursued, and IS-ENES2 contributions were very important in many ESGF working teams.

Interoperability and standardisation work has been quite active, such as work on defining metadata standards for Statistical Downscaling and Climate Indices, which have started through an international collaboration led in part by IS-ENES2. Significant effort has also been done within ES-DOC to support the upcoming CMIP6.

Dissemination on the climate4impact portal has been regular, in large international and national conferences and events, but also in other European project meetings. It has proven to be quite important to pursue this action because there have been many feedbacks stating that the portal was not always known among many potential users.

**Details for each task:**

**Task 1: Core data services**

*Quality Control*
Work has been steadily going on regarding Quality Control, notably with the release of **MS5.3** (*Consultation on Quality Control Requirements*) on 2015-03-20. The development has been going on at DKRZ, and one WCRP Training Workshop for the QC tool has been organized in CORDEX Asia on 17-20 November 2014 at Citeko Bogor (Indonesia).

*ESGF Project Management*
Many partners have been involved significantly in several ESGF Working Teams: SMHI, DKRZ, CNRS-IPSL, STFC, CMCC, KNMI, CERFACS. This involvement gives the opportunity for ENES to contribute to the roadmap and decisions regarding the ESGF infrastructure.

*Subtask 1.1: Governance and general requirements*
General governance aspects were tackled within the ESGF governance (ESGF-XC) working team, along with the Network Path Optimization (ICNWG) working group. Involvement in other committees and panels were also related to governance, notably the WGCM Infrastructure Panel (regular telcos), and CMIP6 data management. The Data archive governance and requirements

deliverable **D5.1** was published.
Significant work was achieved in gathering requirements for CMIP6: several papers were written under the WIP: data quality control, versioning, replication, data identification and data citation.
Supported by both IS-ENES2 and EUDAT2020, work was done on the interoperability between ENES and other infrastructures: harvest of ENES data into EUDAT search catalogue (B2Find) was done, as well as discussions on ENES/EUDAT near-the-storage workflow compute solution interoperability (WPS – GEF), in the context of Big Data Analytics. Also, first ENES inputs were handed to ENVRIPlus processing, provenance, data identification and data citation WPs.
Finally, collaboration between partners lead to a joint participation in a Copernicus Call for European ESGF data/compute nodes (STFC, DKRZ and CNRS-IPSL).

*Subtask 1.2: Terms of use*
Most of the work was done in RP1, but partners contributed to the WGCM Infrastructure Panel white paper on data licensing.

**Task 2: Meta-data, interoperability and standardisation**
Significant work was done on metadata and experiment specification regarding the upcoming CMIP6, under the ES-DOC framework. CIM2 definition and tools were developed, and specification documents for CMIP6 experiments were written. Consolidation of community requirements for CMIP6 Data Request was done.
Controlled Vocabulary for Empirical Statistical Downscaling (ESD) has been defined in collaboration with the US NCAR NCPP program. ESD Metadata and data syntax (DRS) standards were also defined in strong collaboration with CORDEX-ESD, COST VALUE and FP7-CLIPC. Furthermore, Metadata and DRS standards for climate indices and indicators were also defined in strong collaboration with FP7-CLIPC, and a joint workshop was organized to speed up the work.

**Task 3: Requirements for the impact user communities**
Continuous work on gathering requirements for the impact user communities was done, with two workshops on developing a Community Of Practice, a CORDEX-ESD workshop, and a joint workshop with CLIPC on user requirements held on 2015-02-03 (Summary Report available).
To get needed statistics on user access, dashboard and metrics collection were put in place.
Based on user feedbacks, updates on documentation and use case pages on climate4impact.eu were done, along with improvements of the climate4impact homepage.
Collaboration and discussions were established with FP7-CLIPC, FP7-SPECS, FP7-EUPORIAS projects, as well as with the ESGF Compute Working Team (CWT) and ESGF Identity Entitlement and Access Management Team (IDEA) (KNMI).

**Significant results:**

**Task 1:**
- Release of **MS5.3** (mo 24) on quality control requirements
- The publication of 1Pb of replicated CMIP5 data has been completed as well as the publication of climate model data from the FP7 project SPECS (seasonal to decadal predictions) and the international Chemistry-Climate Model Initiative (CCMI), and of one ESA Climate Change Initiative dataset.
- Publication of **D5.1** on Data archive governance and requirements (mo 34), with a draft (**MS5.1**) produced in month 20.
- Contribution to the first "ESGF Implementation Plan".

**Task 2:**
- Regarding the upcoming CMIP6, initial assessments of new CF Standard Names were done, along with experiment definitions (ES-DOC; 50% completed by Feb 11th, 2016) and the Data Request and API were published in draft form.
- Metadata/CV and DRS standards for new data types were defined and implemented: Empirical Statistical Downscaling (ESD), climate indices/indicators and observations, with a worldwide

collaboration.
- **MS5.2** on Consultations on Data Access Protocols was released 2015-06-30.

**Task 3:**
- Requirements for new categories of users were gathered.
- Strong collaboration established with other FP7 projects as well as ESGF Working Teams.

**Deviations from Annex I (DoW) :**

**Delay of D5.2 "Assessment of impact communities requirements" (Task 3).** Initially planned on mo 36 is delayed to June 2016 (mo 39). ESGF suspension had indeed significant impacts on climate4impact access and user requirements evaluation, causing delays do **D5.2** Assessment of impact communities' requirements.

**Reasons for failing to achieve critical objectives and/or not being on schedule**:

**Use of resources:**

**STFC, 2.29 PM** used (23 PM total project). Work on ES-DOC experiment specifications. Staff usage will be higher in the final period; in this period STFC has benefitted from synergies with FP7 CLIPC.

**CERFACS, 14 PM** used (18 PM total project). A lot of work has been accomplished in dissemination as well as metadata standards developments. Temporary staff has been employed hence the higher number of PMs used in this period. Next period will lead to much lower staff usage.

**CSAG, 5.21 PM** used (14 PM total project). Work on engaging with the CORDEX-ESD community around their requirements and engagement with meta-data standards and archiving. Development of an experimental CORDEX-ESD experiment submission platform. Collaboration with te UC COST-VALUE platform. CSAG also engaged with impacts user community and other communities through relevant workshops to further understanding user requirements.

**DKRZ, 5.1 PM** used (12 PM total project). Work on CMIP6 requirements documents and specifications on quality control, replication and versioning as well as persistent identification.

**SMHI, 2.02 PM** used (9 PM total project). On-going deployment of the DKRZ quality control tool with bug reporting to DKRZ. This includes projects CORDEX and CMIP5. SMHI has prepared and carried out a quality control course on WCRP ESGF Training Workshop for CORDEX Asia in 2014. SMHI has been active in commenting and developing Data Reference Syntax for ESGF deployment. This covers SPECS DRS interpretation, including ESGF pilot publication and Bias Correction CORDEX DRS development.

**KNMI, 1.28 PM** used (8 PM total project), effort has been focused around promoting and improving usage of the climate4impact portal by providing help to users and actively present climate4impact at conferences and meetings.

**WU, 1.84 PM** (8 PM total project), contributions to portal development sessions. Formulation of user cases.

**UC, 5.25 PM** used (6 PM total project). The development of use cases and metadata definition and integration specification of the Downscaling and Climate4Impact portals has taken 3PMs. We have a deviation of 2.25PMs because of the Evaluation and deployment of the ESGF/CORDEX specification including an ESGF test and production node deployment for publishing CORDEX-RCM datasets.

**CMCC, 0.79 PM** used (4 PM total project). Participation to the ESGF working teams (IWT, CWT, Dashboard-WT), preliminary draft of the roadmap for the Dashboard Working Team and review of the terms of use. The number of person months is higher than initially planned because figures with a lower monthly rate have been employed.

**CNRS-IPSL, 3.42 PM** used (3 PM total project), ensured the coordination of ES-DOC and the IS-ENES contribution to CMIP6 documentation efforts. Work included: the definition of CIM2 classes, model description syntax, workflows to organise the CMIP6 documentation process, interaction with WGCM/WIP and wider community and management (meeting in March 2016, weekly teleconferences).

**MF-CNRM, 1.99 PM** used (3 PM total project). Specifications of CORDEX data formats have been field-tested on a real case, leading to the tuning of ESGF configuration files in order to cope with metadata describing Lambert-conformal projections. Euro-CORDEX CNRM-ALADIN simulations were published on ESGF.

**UNIMAN, 0 PM** used (2 PM total project). With the agreement of the project officer, UNIMAN used some of their IS-ENES2 funding to partly support the living costs of a PhD student from September/October 2015 until the end of the project rather than on pms. This affects the final total person months claimed for this work package but not the activity.

**DMI, 0.78 PM** used (2 PM total project). The DMI has assisted in the implementation of terms of use and has been part of the team responsible for interaction with data providers and registration of the proper terms of use for the respective datasets.

**Corrective actions: none**

# WP6/NA5: Innovating on climate modelling

| Work Package Number | *WP6/NA5* | | Start Date or Starting Event | | | | Month 1 | |
|---|---|---|---|---|---|---|---|---|
| Work Package Title | Innovating on climate modelling | | | | | | | |
| Activity Type | *COORD* | | | | | | | |
| Participant Number | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 14 |
| Participant Short Name | CNRS-IPSL | DKRZ | CERFACS | CMCC | UREAD-NCAS | STFC | SMHI | WU |

**Summary of progress of the work package:**

This work package is addressing two groups of external users or collaborators. The first is the ICT industry, where the aim is to improve collaboration and create a culture of co-design aiming to facilitate efficient use of future computer architectures and systems for climate models. The second category aims to reinforce relations with providers of climate services in order to stimulate innovation in this field and better use results and expertise from IS-ENES2.
Activities in this part of the WP have been affected by the start of the FP7 Copernicus CLIP-C project in 2014. CLIP-C integrates model results with observational datasets for a large range of users in the context of climate services and overlaps with initial task 3 objectives. Relations between IS-ENES2 and CLIP-C have further evolved during this reporting period and the climate service user oriented activities are being executed in cooperation between the two projects. This has resulted in some reorientation of tasks and deliverables.

**Details for each task:**

**Task 1: Facilitate innovation through collaboration with ICT companies**
IS-ENES2 has contributed to the preparation of 4th ENES HPC workshop held in collaboration with the ESiWACE project in April 2016 in Toulouse. A specific session on "New paradigms (languages, standards and next generation models" and a round table discussion will provide a basis for in depth discussion of innovation relevant to climate models.
A collaboration has been developed with INTEL.A prototype of the NEMO hybrid parallel version based on the use of MPI and OpenMP was developed, starting from the analysis of three different approaches implemented and tested using mini-apps. CMCC provided the code prototype to INTEL, which worked to optimize it on INTEL architectures.

**Task 2: Facilitate innovation through the transfer of climate knowledge to consultancies and corporates**
Progress in this task is satisfactory, through the development of master classes (see below: Deliverable **D6.3**) on the use of climate data for adaptation strategies. Initially it proved to be difficult to interest consultants and SME's for these training sessions, and therefore Wageningen University students, following a consultancy course, were enrolled in the training. But in two occasions (with Colombian coffee growers and with European adaptation consultants; see below) meaningful transfer of climate knowledge towards consultants was successfully accomplished using material from the training session.

**Task 3: Facilitate societal innovation**
This task has been impacted by the context of collaboration with CLIP-C as well as the launch of the Copernicus Climate Change Service. This has delayed the **D6.2** report on Needs for climate services. Workshops with C3S as well as activities within CLIP-C have however provided many useful input that will help prepare **D6.2** on how IS-ENES can contribute to the development of climate services within Copernicus. IS-ENES2 was also proactive as contributing to C3S by answering a call for tender on accessing climate projections.

Work on requirements for the impact user community was done as a contribution to WP5 and in the frame of the development of the Climate4Impact portal. Connections between EU research experiences (Clearing House, CIRCLE2, ECLISE, CLIMRUN, EUPORIAS) on IAV information sharing has contributed to development of new case study storylines (on seasonal forecasts) and the introduction of hydrological indicators on the Climate4Impact portal.

**Significant results:**

**Task 1:**

- A prototype of the NEMO hybrid parallel version provided to INTEL as basis for optimization.
- Co-organisation of the 4th ENES HPC workshop (April 2016) including interactions with vendors.

**Task 2:**

- A master class/training on the use of CMIP5 and CORDEX data was developed in collaboration with CLIPC and was given on three occasions.
- Deliverable **D6.3** Prototype master classes for SMEs and corporates, was produced.
- The master class is also scheduled for April 2016 as a training module in the Copernicus/SWICCA project specifically dedicated towards consultancies. Preparations for this training have been made during reporting period 2.

**Task 3:**

- IS-ENES2 contributed to the scoping workshops of the Copernicus C3S on the climate data store and on climate projections.
- From the task 3 perspective: *strengthen the link between the ENES community providing climate projections and the community developing climate services* and using workshops in the frame of the Copernicus CLIPC and Swicca projects contributions were made to the Climate4impact portal. The contributions were: introduction of guidance, introduction of cases on seasonal forecasts, introduction of hydrology indicators.

**Deviations from Annex I (DoW)**

**D6.2** Report on "needs for climate services" (Task 3) is delayed following the change of context: the CLIP-C project and the launch of the Copernicus Climate Change Service. Production has started but completion is scheduled for late 2016.

**Reasons for failing to achieve critical objectives and/or not being on schedule**

n/a

**Use of resources:**

**CNRS-IPSL, 1.78 PM,** contributed in Task 3 to the scoping workshops on Copernicus C3S.

**DKRZ, 0 PM**, is actively involved in networking activities focused on the identification and optimal exploitation of synergies between projects, national and European (especially between IS-ENES2 and ESiWACE). DKRZ co-organized the 4th ENES HPC Workshop in Toulouse and established collaboration with Atos/Bull. No personnel cost is claimed for this period.

**CERFACS, 0 PM,** no activity is reported during this period.

**CMCC, 4.55 PMs**, on Task1 collaborating with INTEL on NEMO model development. The number of person months is higher than initially planned because figures with a lower monthly rate have been employed. However, the budget spent for the activity is always 14k€.

**UREAD-NCAS, 0 PM,** no activity is reported during this period.

**STFC, 0 PM**, STFC contributes to linking IS-ENES2 to climate services through the FP7 Climate Information Platform for Copernicus (CLIPC, www.clipc.eu) project which is building components and knowledge from the ENES Data Infrastructure into a demonstration data portal for the Copernicus Climate Change Service (C3S).

**WU**, **2.77 PM** (8 PM total project) Development of master class trainings and organisation and giving of three training sessions. Contributions (from the climate service community perspective, to the Climate4 impacts portal. Coordination activities for task 2 and 3.

**Corrective actions: None**

# WP7/SA1: The European Network of geographically distributed services on Earth System models, component models and tools

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Work Package Number** | ***WP7/SA1*** | | **Start Date or Starting Event** | | | **Month 1** | |
| **Work Package Title** | **The European Network of geographically distributed services on Earth System models, component models and tools** | | | | | | |
| **Activity Type** | *SUPP* | | | | | | |
| **Participant Number** | **3** | **1** | **8** | **9** | **21** | **6** | **22** |
| **Participant Short Name** | **CERFACS** | **CNRS-IPSL** | **SMHI** | **KNMI** | **MF-CNRM** | **MetO** | **UiB** |
| **Participant Number** | **10** | **4** | **23** | **2** | | | |
| **Participant Short Name** | **MPG** | **CMCC** | **met.no** | **DKRZ** | | | |

**Summary of progress of the work package:**

During the second period, level 1 services were continued on all European ESMs as well as level 2 services on EC-Earth and on the Unified Model. Services on NEMO ocean model and OASIS and CDO tools were offered as planned, and new versions of these software model and tools were released. Two WP milestones of the period were delivered, in particular the 1st review report on the ENES Earth System Model Resources (CERFACS) by K. Puri (ACCESS, AU) and A. Will (COSMO, DE) that provided valuable advices on how to improve these. One milestone, i.e. the 2nd review report is delayed by 6 months as it was decided to use the second period report as an input to this milestone. Finally a paper helping users to understand and use the sea-ice model LIM3 included in NEMO was published (see Significant Results below).

**Details for each task:**

**Task 1: Managing the ENES Earth System Model Resources**

During the second period of the project, frequent contacts and mail with the ENES portal manager and with the different ESMs groups were exchanged to ensure that the ESM portal pages were kept up-to-date and modified according to the reorganisation realized after the mid-term project review. Interactions with K. Puri (ACCESS, AU) and A. Will (COSMO, DE), members of the service review committee, also took place so to facilitate their work and the production of the 1st review report on the ENES Earth System Model Resources.

**Task 2: Services on European ESMs**

Different levels of services were continued on the different ESMs during the second reporting period.

For all European ESMs used to run the CMIP5 simulations, i.e. CMCC-CESM, CNRM-CM5, MPI-ESM, EC-Earth, IPSL-CM5, HadGEM2, and NorESM, level **1** services have been offered. These services ensure that the ESM CIM description established during IS-ENES1 is accessible through the ENES portal and that a contact person, with contact details available on the portal, is identified to answer specific questions about the ESM when needed.

Statistics on portal hits for the ESMs pages and detail per ESM are available at https://verc.enes.org/awstats/awstats.pl?config=esm. These statistics, started in August 2014, cover the whole second period. They show that the number of accesses to the ESMs pages is quite constant in time with a slight increase in 2016 reaching a maximum of 1191 unique visitors in March 2016 (for

a minimum of 545 in December 2014). They also show that people from all over the world access the ESMs pages, with a maximum of people from the USA. Finally one can notice a sensible difference between the different ESMs, with e.g the UK MetOffice HadGEM2 pages being hit 617 times in 2015 while the EC-Earth pages were accessed only 127 times.

**At level 2**, services have been offered by SMHI on EC-Earth and by MetO on the Unified Model.

EC-Earth development portal at https://dev.ec-earth.org was maintained with two version releases (EC-Earth 3.2alpha and 3.2beta), 60 new issues reported and 37 issues closed, 25 new wiki pages and 35 wiki updates, and 182 messages posted on the forum during the period. These services greatly helped the outreach of EC-Earth as shown by the current 170 users including 72 new users during the period. Finally, in-person support for EC-Earth installation and use was provided to University of Stockholm and Uppsala University.

For HadGEM2, support pages on TWiki collaboration platforms were setup and updated, and a newsletter was created and distributed. Information on HadGEM2 on the IS-ENES pages were regularly reviewed and updated, and a new method for delivering HadGEM configurations, updates, and model input files, making the process more accessible and easy, was implemented. More specific technical user support on the latest HadGEM configuration was also provided to the Meteorological Administration (Korea), the Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation (Australia), and the National Institute of Water and Atmospheric Research (New Zealand). These services extend the use of European models outside the MetO and Europe and facilitate effective collaboration with scientists in the meteorological, climatological and university communities from all over the world.

**Task 3: Services on NEMO ocean model component (installation 8) (CNRS-IPSL)**

As during the first period, NEMO services are organized around the existing web site http://www.nemo-ocean.eu/ referenced on the ENES portal, which provides detailed and up-to-date information on the code sources (managed under Subversion), reference manuals, user guides, announcement and news on forums and meetings, development information using a Trac ticketing system. Statistics available for the last 12 months show that these services provided:

- 1500 changes of the NEMO source code
- 300 edits of the wiki pages (documentation, description of on going work)

Furthermore, the KPIs, defined after the mid-term review, have the following values for the last 6 months, i.e. from 10/2015 to 03/2016 (values for the previous 6-month period from 04/2015 to 09/2015 are also provided as a reference):

- Number of downloads for NEMO: 1112 (1235)
- Number of discussions and mails exchanged for NEMO 80 (60)
- Number of tickets opened/closed for NEMO 215/220 (107/106)

Finally, milestone **MS7.5** "Documentation of the reference and sensitivity experiments based on ORCA025 configuration of NEMO" (originally due month 24) was produced and one paper on the sea-ice model LIM3 included in NEMO was published (Rousset et al. 2015, see significant results).

**Task 4: Services on ESM tools**

All these services are available since the beginning of the project.

**OASIS (installation 9) (CNRS-IPSL, CERFACS)**

During the second period, the services around OASIS have consisted in (values for the first period are also provided as a reference):

- Maintaining the most up-to-date sources and documentation available on the Subversion server: 549 change sets registered (558 during the first period).
- Distributing them to the climate modelling community through the OASIS web site

(https://verc.enes.org/oasis) accessible through the ENES portal (see the KPI below).
- Updating the Redmine development tickets, see https://inle.cerfacs.fr/projects/oasis3-mct : 475 updates (219 during the first period).
- Active user support was also provided mainly through mail exchanges and few phone conversations (see the KPI below).
- Following and updating OASIS forum conversations (see the KPI below).

These services helped users on specific issues and provided guidance on how to use the software on specific platforms and in particular configurations.

The KPIs, defined after the mid-term review, have the following values for the last 6 months, i.e. from 10/2015 to 03/2016 (values for the previous 6-month period from 04/2015 to 09/2015 are also provided as a reference):
- Number of downloads for OASIS: 68 (106)
- Number of discussions and mails exchanged for OASIS: 93 mails and 20 forum exchanges, i.e. 113 in total (118)
- Number of tickets opened/closed for OASIS: 4/6 (5/3)

**CDO (installation 10) (DKRZ)**

As during the first period, services included running the CDO helpdesk and webserver set up, accessible via the ENES portal. In particular, up-to-date documentation, FAQ, and help form are accessible through the ENES portal.

The KPIs, have the following values for the last 6 months (values for the previous 6-month period are also provided as a reference):
- Number of downloads for CDO: ~5700 (6374)
- Number of discussions and mails exchanged for CDO: ~100 mails and 224 forum exchanges, i.e. 324 in total (550)
- Number of tickets opened/closed for CDO: 43/51 (18/72)

**Significant results:**

1. The two WP milestones of the period were delivered (see the specific reports):

- **MS7.5** (mo 35, originally due mo 24): Documentation of the reference and sensitivity experiments based on ORCA025 configuration of NEMO (CNRS-IPSL)

- **MS7.4** (mo 24): 1st review report on the ENES Earth System Model Resources (CERFACS) by K. Puri (ACCESS, AU) and A. Will (COSMO, DE). Main outcomes are:
  - Good general feedback on ENES portal, but very few remarks on level 2 service because of lack of time.
  - NEMO web site regarded as exemplary or 'perfect'; CDO & OASIS sites "comprehensive and very useful"; OASIS "support goes beyond what can be expected"
  - All difficulties mentioned were addressed following the mid-term review (confusing structure of ES Models and Modelling Groups pages on portal, CIM views of ESM were not accessible, some ESM contacts outdated.

2. Version 3.0 of OASIS3-MCT was released in May 2015: sources are available on the OASIS web site (https://verc.enes.org/oasis) accessible through the ENES portal. Since May 2015, about 150 downloads of OASIS3-MCT_3.0 were registered from groups in Europe but also in USA, Mexico, Canada, Perou, Chile, Australia, China, Saudi Arabia, South Africa, Algeria, Egypt, Siberia, Singapore, South Corea, Thailand, Iran, India, Czech Republic, etc.

3. Paper on NEMO published documenting the LIM3 sea ice component (Rousset etal., *Geosciences Model Development*, 2015, doi:10.5194/gmd-8-2991-2015)

**Deviations from Annex I (DoW) :**

**MS7.5**, originally due mo 24, was in fact delivered at mo 35 but this did not have any impact on other tasks.

**MS7.6** "2nd review report on the ENES Earth System Model Resources" due mo 36 is delayed by 6 months.

**Reasons for failing to achieve critical objectives and/or not being on schedule** :

**For MS7.5**, the delay was due to the late recruitment of a research engineer at CNRS-IPSL.

**For MS7.6**, the delay of 6 months is linked to the fact that we now consider that the 2nd periodic report should be used, among other material, as an input to the reviewers to produce their report.

**Use of resources:**

**Operational costs / Access cost for each partner:**

**CERFACS: 0.9 PM,** has coordinated the WP7/SA1 (task 1) and has provided services on OASIS.

- Operation costs for the first reporting period: **6 729€**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **1440€**

**CNRS-IPSL** is the main provider of services on NEMO, is involved in services on OASIS and has provided level1 services on IPSL-CM5

Installation on ESM tool OASIS:

- Operation costs for the first reporting period: **82 015,76 €**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **17 551,37 €**

Installation on NEMO ocean model:

- Operation costs for the first reporting period: **172 573,18€**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **36 930,66€**

Installation on IPSL-CM5:

- Operation costs for the first reporting period: **142 881,09 €**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **30 576,55 €**

**SMHI** has provided level2 services on EC-Earth.

- Operation costs for the first reporting period: **77 334€**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **16 549€**

**KNMI** has provided level2 services on EC-Earth.

- Operation costs for the first reporting period: **62 350 €**
- Percentage of the operation costs charged to the project: 20%

- Access cost charged to the project for the first reporting period: **13 343€**

**MF-CNRM** does not request access cost, although has provided level1 services on CNRM-CM5.

**MetO** has provided level2 services on Unified Model and HadGEM2
- Operation costs for the first reporting period: **55 501€**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **11 877€**

**UiB** has provided level1 services on NorESM.
- Operation costs for the first reporting period: **50 998€**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **10 914€**

**MPG** does not request access cost, although has provided level1 services on MPI-ESM and services on CDO.

**CMCC** does not request access cost, although has provided level1 services on CMCC-CESM

**Met.No** has provided level1 services on NorESM
- Operation costs for the first reporting period: **9 788€**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **2 095€**

**DKRZ** does not request access cost for this period, although has ensured the ENES portal maintenance.

**Corrective actions:** No action needed.

# WP 8 / SA2: ENES Climate Data Services

| Work Package Number | *WP8 / SA2* | | Start Date or Starting Event | | | Month 1 |
|---|---|---|---|---|---|---|
| Work Package Title | ENES Climate Data Services | | | | | |
| Activity Type | *SUPP* | | | | | |
| Participant Number | 1 | 2 | 7 | 9 | 15 | 19 |
| Participant Short Name | IPSL | DKRZ | STFC | KNMI | LIU | DMI |

**Summary of progress of the work package:**

All services of the previous reporting period were continued and most of them improved. The highlight undoubtedly was the ability of IS-ENES to hand out CMIP5, CORDEX and other data during the six months downtime of the ESGF data dissemination system. The graphs below show this effect impressively. Improvements concern: the support for CORDEX data retrieval, the quality control service, the CIM user interfaces, and the complete Climate4Impacts portal.

**Details for each task:**

**Task 1: Core Data services**

**1.1 User support:**
Until end of 2014 the ENES CDI Help Desk had been provided by the ESGF AskBot system, which is an open community-driven question and answer web application. However, it turned out that this system is not enough protected against misuse by spammers, so it had to be removed. So the user support has been switched back to a mailing list.
In the reporting period, the 2nd level support for more detailed questions could be improved; volunteering specialists could be found for the topics concerning GLOBUS interface, Mac users, GIS/impact scientists, and the projects CMIP and CORDEX. With the knowledge that had been contained in the AskBot, a FAQ area has been installed in the GitHub system.
From June 2015 to January 2016 the ESGF system was down due to a security issue, from October 2016 some test nodes were up again. During this overhaul, the support went on, on lower level. Afterwards, a revision of the FAQ list was necessary, caused especially by the new user interface.

**1.2 CORDEX Support:**
In RP2, LIU and DMI run ENES data nodes and operated the ESGF CORDEX attribute service, which administers the assignment of users to their rights and other parameters, as an uninterrupted service over the whole reporting period. In addition, they set up and operated a temporary SMHI CORDEX download service (4th Sept 2015 to 7th January 2016) for users during ESGF downtime. Many scientists used this service and more than 4TB of CORDEX data (equivalent to more than 25000 datasets) were downloaded from this temporary service over the period. Furthermore over 50 (conservative estimate) CORDEX data access related support tickets were answered. In addition, all available CORDEX data were replicated to DKRZ (see esgf-data.dkrz.de/search/cordex-dkrz/).

**1.3 Quality Control Service:**
The running support for the ENES data nodes (LiU, KNMI, DMI, DKRZ, CNRS-IPSL) continued. In addition, the use of the QC tool was extended and supported to data producers (AWI (DE); DHMZ (Croatia); DMI (DK); GERICS (DE); IPSL (FR); KNMI (NL); LiU (SE); NIMS (Korea); MPIM (DE); SMHI (SE); UQAM (Canada)) to have the checks earlier in the data stream. The support comprised installation and running of the QC tools as well as interpretation of the results. This was run on the improved version of CMIP5 Quality Control, which is available to ENES CDI and documented in **MS8.6** (*Improved version of CMIP5 Quality Control available to ENES CDI*).

**1.4 Low Level Data Access:**
For the ESGF Data Nodes, the support on installation and running went on. This comprised support of data nodes in node installation and maintenance. Support in the use of the interfaces was given, too.

**Task 2: Meta Data Services**

**2.1 CIM Governance:**
The continuous biweekly transatlantic phone conferences of the ES-DOC project on CIM related issues went on.

**2.2 CIM Repository:**
The services on CIM Metadata have been on going. Their features have been reviewed and are currently further developed. These are CIM Creation Services (ES-DOC python client, CMIP5 questionnaire, ES-DOC questionnaire) and CIM Viewing Services with the CIM viewer plugin. In addition, a CIM Document Comparator (front-end and API) and search capabilities (front-end and API) were established. All those services were integrated (**MS8.3**) and can be accessed from es-doc.org. For each of them a statistics is available on the web (http://stats.api.es-doc.org/cgi-bin/awstats.pl) via a monitoring tool. A quality control for the CIM data has been implemented. In addition, there is a user oriented description of the services on the ENES website at verc.enes.org/data/enes-model-data/cim-metadata-standard. Further information on the development and the transatlantic cooperation can be found at http://es-doc.org/.

**Task 3: Enhanced Data and Information Access**

**3.1 ENES Data Portals:**
a) ENES portal: During the downtime of ESGF (2015-06 to 2016-01) web information on alternative access points to use was given via the ENES portal and was widely used. After the overhaul, revisions of the portal were necessary, caused especially by the new ESGF user interface (e.g. commented screenshots). In addition, many new pages were generated, especially on projects (e.g., CMIP5 and CORDEX). Furthermore, the recommendations of the reports by external referees were integrated.

b) Climate4Impacts portal: Via the portal KNMI provided answers to questions from different users. They actively maintain a LinkedIn group on climate4impact. Because of the ESGF being not available, Climate4Impacts experienced a drop in usage and questions in the second half of 2015. At Climate4Impacts among others, the following improvements were made on user request (partly overlaps JRA activities, **MS8.5**): Search interface speed has greatly been improved by using short lived (1 minute) caches; Improved error handling in C4I for ESGF data nodes, catalogs are checked in advance for availability. Catalog status is clearly indicated to the user; Development of combine and subset wizard; for sub setting, reprojecting and reformatting data; Web Processing Service graphical user interface now supports complex inputs; Added a per-user opendap server on files in user's basket; Added Google OAuth2 login screen. Allows for easy login, upload of your own data, processing of your own data and visualization of your own data. Does not work with ESGF datasets which require an ESGF Group registration; API for climate4impact has been documented and is used by CLIPC project.

**3.2 Support:**
User support for Enhanced Data and Information Access was given together with the core support (Task 1.1, see there).

**3.3 Outreach:**
Outreach activities were carried out at three conferences. On the EGU General assembly and on the AGU Fall Meeting at San Francisco Posters were shown. A detailed talk on the Support Working Team was given on the ESGF Face to Face conference at Monterey (T. Rathmann, co-lead, DKRZ). KNMI provided support for two Classroom exercises, where students at Wageningen University used the climate4impact portal. Support consisted of prioritizing issues essential for conducting the

classroom and being there at the classroom itself.

**3.4 Review report:**
At the beginning of RP2, the reporting process started with a phone conference. Afterwards reports of three scientists could be gathered and were summarized in **MS8.4**. These results were made accessible on the website, too. As for the 2nd review report on ENES CDI (MS 8.7) contacts to the reviewers is prepared to invite them for a second evaluation. MS87 is planned to be ready at M42.

**Significant results:**

The most effective and significant result of the WP8 service work is probably that despite the overhaul of ESGF in the second half of 2015, IS-ENES could help users to get the CMIP5 data by: 1) providing access to the IPCC Data Distribution Centre and to the CERA Long Term Archive and 2) providing a long list of alternative access points (mostly data nodes of the data providers) on the IS-ENES website. The latter has been referenced by various ESGF related other websites.

Four of the five milestones for the period were delivered:

**MS8.3** (M24) "Integration of CIM Model and Experiment Repository into ENES CDI": A detailed description of this milestone is available on: https://verc.enes.org/data/enes-model-data/cim-metadata-standard, with information on CIM Portal, CIM Questionnaire and CIM Viewer.

**MS8.4** (M24) "1st review report on the ENES Climate Data Infrastructure": For the review of the IS-ENES2 Data Portals a review committee was established, consisting of three external scientists that have an Earth System Research background to review the verc.enes.org/data pages, the climate4impact portal, ENES/ESGF support and related information sources in the web.

**MS8.5** (M32) "JRA3 developed services deployed on CLIMATE4IMPACTS": Climate4impacts adds services to further improve the accessibility of climate model data. The deployed functionality is developed based on user requirements, as stated in requirements surveys (IS-ENES1), and feedback provided by impact users. Also climate4impact is used in classroom exercises at Wageningen University. The climate4impact dissemination effort is described in more detail in the NA4 report.
For further details see climate4impact.eu - this contains the operational version of climate4impact

**MS8.6** (M36) "Improved version of CMIP5 Quality Control available to ENES CDI": The core of the Quality Assurance (QA-DKRZ) package was modularised and expanded to the CORDEX project. CF Metadata Conventions, DRS, CV, variable requirements, and text based project rules were checked. The main improvements were simple installation, automatic updating, and a default configuration. Check results are issued in the YAML format and stored unambiguously. The package is commonly accessible from https://github.com/IS-ENES-Data/QA-DKRZ. A user-guide is available on https://readthedocs.org/projects/qa-dkrz. At present, QA-DKRZ is used in various countries in Europe, North America, and Asia.

**Pictures on significant results:**

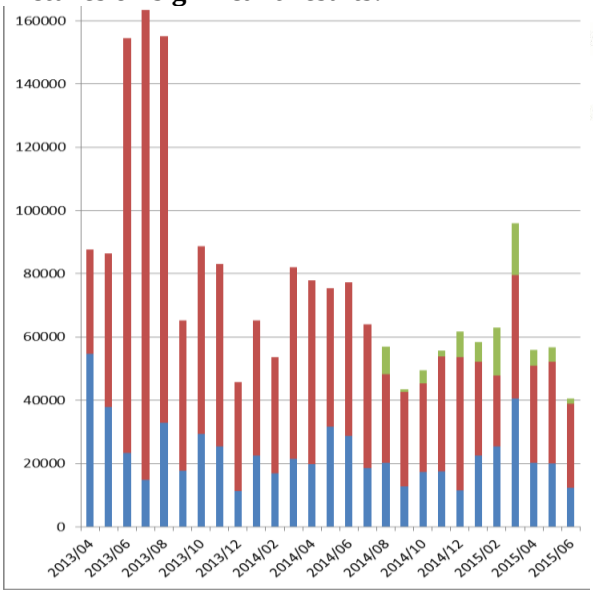



*Fig 1: Download volumes [GB], from ENES ESGF nodes, accumulated over projects.*

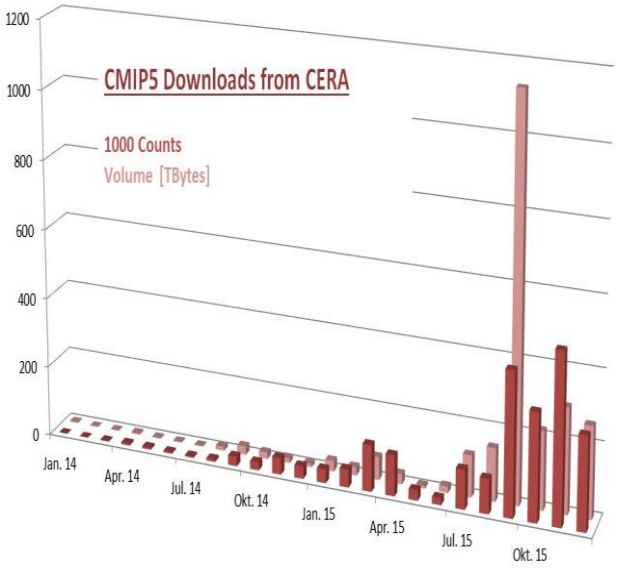



*Fig 2: CMIP5 download strongly increased after the ESGF downtime began in June '15.*

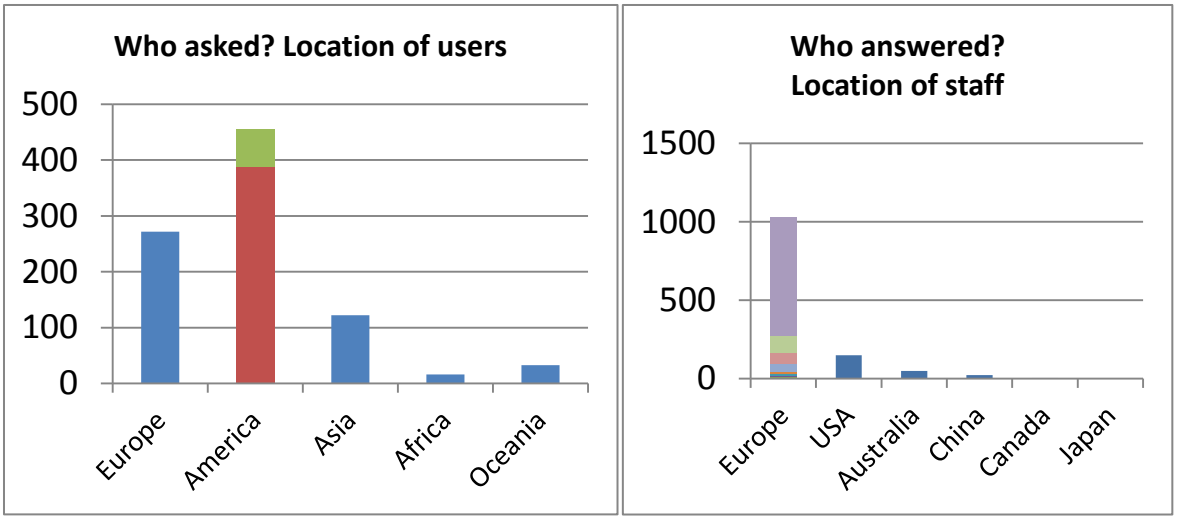



*Fig 3: The statistics of users and staff show that IS-ENES did a very significant part of the user support (data for Dec 2013 – Sep 2015).*

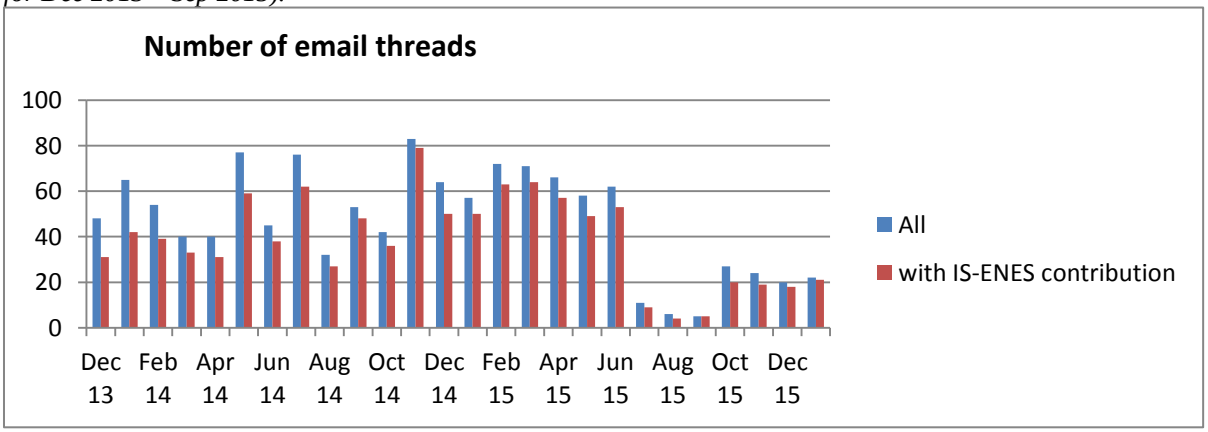



*Fig 4: Number of queries by mail that were received at DKRZ, not including the requests sent to other IS-ENES partners directly.*

**Deviations from Annex I (DoW):**

**MS8.7** (*2nd review report on the ENES Climate Data Infrastructure*) has been postponed by six month for two reasons. Firstly, it seemed reasonable to arrange and implement some more enhancements to the CDI than we had after less than 12 months. Secondly, the delay allows using the 2nd periodic report, among other material, as an input to the reviewers to produce their report.

**Reasons for failing to achieve critical objectives and/or not being on schedule**:

The main issue during RP2 has been the international downtime of ESGF. However, as mentioned above, IS-ENES2 managed to continue the service through access to the IPCC and CERA databases. For CORDEX, a temporary service was implemented by SMHI.

**Use of resources:**

**DKRZ**, WP lead, user and data node (DN) support including DN statistics and maintenance of IS-ENES data website; storage in long term CMIP archive, including quality checks, and affiliation of a Digital Object Identifier (DOI).

- Operation costs for the first reporting period: **1 150 468€**
- Percentage of the operation costs charged to the project: 14.2%
- Access cost charged to the project for the first reporting period: **176 377€**

**STFC,** CIM, user and data node support which includes running the CIM portal for user access

- Operation costs for the first reporting period: **598 072€**
- Percentage of the operation costs charged to the project: 10.5%
- Access cost charged to the project for the first reporting period: **67 235€**

**CNRS-IPSL**, user and data node support, as e.g., software deployment and installation support; es-doc.org and associated services have been continued. A quality control has been undertaken on the CIM content and all es-doc services have been equipped with a monitoring tool.

- Operation costs for the first reporting period: **94 919,45 €**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **20 312,76 €**

**LIU**, CORDEX user and data node support by operating ESGF CORDEX attribute service, setting SMHI CORDEX download service (4 Sept 2015 to 7 Jan 2016) during ESGF downtime and answering >50 CORDEX related questions.

- Operation costs for the first reporting period: **15 215€**
- Percentage of the operation costs charged to the project: 20%
- Access cost charged to the project for the first reporting period: **3 256€**

**DMI**, CORDEX user and data node support. DMI has maintained and operated an ESGF index node as well as a data node until the entire ESGF network was taken down in the summer of 2015. During the entire RP2, data from other institutions have been received, quality controlled, and hosted at the DMI server, such that the DMI data node currently offers data from 5 different institutions. At the very end of the reporting period, work in collaboration with DKRZ has resulted in setting a data node online since 1/4/2016. According to ESGF strategy, this node is only functioning as a data node.

- Operation costs for the first reporting period: **91 197,41€**
- Percentage of the operation costs charged to the project: 20%
  Access cost charged to the project for the first reporting period: **19 516,25€**

**KNMI**, worked on Climate4Impact including user support & statistics. Improved performance of search interface, error handling in C4I for ESGF data nodes, development of a wizard for sub-setting etc. A Web Processing Service was included to now also support complex inputs. Easier login and upload, processing, visualisation of own data. API for climate4impact has been documented and is used by CLIPC project.

- Operation costs for the first reporting period: **21 320€**
- Percentage of the operation costs charged to the project: 20%
  Access cost charged to the project for the first reporting period: **4 562€**

**Corrective actions** : none

# WP9/JRA1: Multi model, multi member high resolution Earth System Models

| Work Package Number | *WP9/JRA1* | | Start Date or Starting Event | | Month 1 | | |
|---|---|---|---|---|---|---|---|
| Work Package Title | Multi-model, multi-member high resolution Earth System Models | | | | | | |
| Activity Type | *RTD* | | | | | | |
| Participant Number | 8 | 3 | 1 | 2 | 4 | 10 | 6 |
| Participant Short Name | SMHI | CERFACS | CNRS-IPSL | DKRZ | CMCC | MPG | Met O |
| Participant Number | 9 | 21 | 23 | 18 | 5 | 20 | 16 |
| Participant Short Name | KNMI | MF | met.no | DLR | UREAD-NCAS | IC3 | BSC |

**Summary of progress of the work package:**

JRA1 aims at developing and running a set *of* coordinated multi-model, multi-member (M4) coupled climate simulations, at high resolution (HR). For this, it identifies and tackles leading issues reducing the efficiency of HR M4 simulations.

The second reporting period (RP2) was characterised by an intensive model and component development phase, which was triggered by the approach of CMIP6 and affected most of the contributing groups in WP9/JRA1. Moreover, the new H2020 project PRIMAVERA has led to an intensified collaboration between WP9/JRA1 groups around HR Earth System Models (ESMs) and experiment workflow. Most of these activities have had a direct impact on the planning of the M4 HR experiments, due in the last phase of IS-ENES2.
Particularly the use of common software components, such as model components, coupling infrastructure, I/O subsystems, and workflow tools, require a tight coordination between WP9/JRA1 contributing groups.
Further activities in RP2 were directed at securing the computational resources needed to perform M4 HR experiments. The work package has contributed to joint acquisition of resources through PrACE. These activities will have to be continued in the next phase of the project.

**Details for each task:**

**Task 1: Preparation of M4-HR simulations**
The development of the particular ESM versions to be used in the M4-HR experiments has been the highest Task 1 priority in RP2. These development activities needed to be coordinated with the upcoming CMIP6 and other international projects. For example, modelling groups have been integrating the new version 3.6 of the NEMO ocean model, the new coupler OASIS3-MCT 3.0, and the new XIOS 1.0 version. As a result, many of the ESM development groups have released new versions of their models.
Furthermore, the coordination of the M4-HR experiments has continued: the list of participating models has been finalised (Task1.3) and the rough outline of the experiment layout has been agreed upon. A discussion about securing of computational resources has been initialised.

**Task 2**: **Improved coupling interfaces**
For task 2.1, the latest version of the fully parallel coupler OASIS3-MCT_3.0 was released in May 2015 (**MS9.4**). This version offers more flexibility in the coupled application layout. For example, the components to be coupled can now run sequentially or concurrently on the same or on disjoint sets of cores within one same executable. Scaling tests realised on Curie, the Bullx supercomputer at the TGCC (Bruyères-le-Chatel, FR), show that the coupler offers good performance for at least up to 16 000 cores per component.
For Task 2.2, the initial interfaces (model code routines where the calls to the OASIS API are located) of three models participating in the multi-model multi-member experiment (the Met Office Global Coupled model, EC-Earth and CNRM-CM) needed to be adapted to the new OASIS3-MCT

coupling routines (**MS9.7**). Centres took this opportunity to rethink or extend their coupling strategy: grid to grid interpolations were changed, and more model components were added to the coupled systems.

**Task 3: Improvements to I/O performance**

**For Task 3.1**, further development of the CNRS-IPSL I/O Server (XIOS, **MS9.8**) and its integration into contributing ESMs has been worked on (**MS9.3**). Particularly, XIOS has been integrated into the atmospheric component of EC-Earth, as well as into the HadGEM3 model. Performance analysis has been performed with the XIOS-HadGEM set-up for high (ORCA25) and very high (eORCA12) resolution configurations. In parallel, the interfacing of XIOS in "Surfex" Land Surface Model within Arpege atmospheric model was carried on by MF, in a way which combines both full upward compatibility in I/O configuration, and an improved detailed configuration through XIOS XML file, allowing for specifying various operations on output fields (averaging, regriding, etc). Special care was brought to allow the interface to manage the full range of model geometries that are used both in Surfex stand-alone mode and in the mode where it is embedded in the IFS/Arpege atmospheric model. The interfacing of IFS/Arpege to XIOS has also been partially developed in the reporting period, up to the point where any raw diagnostic can be output by XIOS; sharing the post-processing duty between Arpege legacy post-processing system (FullPos) and XIOS deserves special care, and is highly dependent on XIOS capacities regarding interpolation (including vertical interpolation from hybrid vertical coordinates).

**In Task 3.2**, the implementation of CDO-PIO into ECHAM/MESSy has continued: a plug-in module for the MESSy CHANNEL interface was implemented, interfacing the CDO-PIO library. Further in Task 3.2, the I/O server infrastructure provided by CDI-PIO for use in ESMs was continuously improved. The focus was on the implementation of parallel I/O support for the netCDF-4.x file format. Efforts started to handle output data and metadata in completely parallelized/decomposed fashion and to achieve high throughput rates on different HPC systems. A number of bugs were fixed and robustness of the software has been considerably improved (**MS9.5**). Benchmarking of CDI-PIO, based on the implementation in MPI-ESM run at different resolutions, shows a significant reduction of the I/O overhead during model integration. For the MPI-ESM-HR configuration the number of simulated years per day (SYPD) increases from 11 to 18 compared to the previously used serial output.

**Task 4: Post-processing analysis efficiency**
The CDO post-processing software was developed further in RP2 (**MS9.6**), with an emphasis on performance, preparation for requirements for model inter-comparisons, and support for unstructured grids. Since post-processing becomes more and more a bottleneck for large modelling projects, we improved, during the reporting period, the CDO for performance. Furthermore, use of unstructured grids (icosahedral-hexagonal) is now possible.

**Task 5: Submission and job control**
An assessment report (**D9.3**) was written covering Autosubmit and Cylc (and, additionally, ecFlow), comparing key features of both tools and complex workflow generation was evaluated.
Additionally, given the experience gained from **MS9.1** and **MS9.2**, Autosubmit was further developed to improve the documentation, portability, and flexibility.
The Cylc meta-scheduler was developed further, focusing on a wider climate community use. A number of improvements (portability, efficiency, memory footprint, etc) and new features (remote log file retrieval, virtual machine install, etc) make Cylc a suitable option for JRA1/WP9 ESMs.
Based on the Cylc developments, efficient workflows (Rose suites) for high-resolution climate simulations were implemented for the HadGEM3 model and documented in the Virtual Workshop on Configuration Management in Climate Science (in collaboration with WP4/NA3).

**Significant results:**

**Task 1:**
- New ESM version: CNRM-CM6
- New ESM version: EC-Earth 3.2
- Process development for new ESM Version NorESM2 completed (better integrated in the CESM framework and early version test on PrACE Tier-0 computers)
- List of participating ESMs and components finalised (CNRM-CM, EC-Earth, CMCC-CM, NorESM)
- M4 HR experiment layout: Definition of an Demonstrator approach for the M4-HR

**Task 2:**
- OASIS3-MCT_3.0 release (**MS9.4**)
- Updated coupling interfaces for ESMs (**MS9.7**)

**Task 3:**
- New I/O server release: XIOS 2.0 (**MS9.8**)
- Model development: Integrate new I/O server versions and configuration
- Compatibility of WP ESMs evaluated (**MS9.3**)
- New CDI release (**MS9.5**)
- Integration and performance analysis of XIOS in HadGEM3
- Integration of XIOS in EC-Earth at KNMI

**Task 4:**
- New CDO release with improved parallel performance (**MS9.6**)

**Task 5:**
- Assessment report on Autosubmit and Cylc (**D9.3**)
- Contribution to regular releases of Cylc (24 cycles since October 2014)

**Deviations from Annex I (DoW):**

We prefer to delay **D9.2 - HR ESM performance resulting from OASIS updates -** to 2016 second half, when first HiResMIP (high resolution CMIP6 exercise) models will be running and optimized on Tier0 platforms. This won't have any impact on final results: our HR models are already updated with latest OASIS fully parallel version (**MS9.7**).

**Reasons for failing to achieve critical objectives and/or not being on schedule**: n/a

**Use of resources:**

**SMHI, 6.94 PM** on integration of new model components (NEMO, XIOS) and development of M4-HR version, contribution to M4-HR experiment layout, contribution to Autosubmit-EC-Earth runtime environment, WP-lead.

**CERFACS, 14.7 PM** on OASIS3-MCT fully parallel version development, validation, porting, and optimization. Computing performance improvements in ARPEGE-Climat and NEMO models. WP-lead.

**CNRS-IPSL, 14.31 PM** on XIOS2 developments. Development focused on new internal design, enabling more easily the implementation of new functionalities. XIOS2 is now ready to be used

without major modification of model interfaces.

**DKRZ, 2 PM** improvements of the I/O server infrastructure provided by CDI-PIO for use in Earth System Models.

**CMCC, 2.56 PM** on development and testing of CMCC-CM2-VHR very high resolution fully coupled general circulation model, based on a ¼ degree configuration in both atmospheric and oceanic components.

**Met-Office, 10.5 PM** on Cylc development: MetO contributed to most of the 24 releases during RP2, (MetO developers (benfitzpatrick, matthewrmshin, arjclark, kaday, dpmatthews) commits can be checked here: https://github.com/cylc/cylc). Support of comparative assessment of Autosubmit-Cylc. 2.75PM on efficient workflows (ROSE/Cylc) for highres climate simulations. 4.25PM on XIOS and OASIS3-MCT development, performance analysis, and integration in HadGEM3.

**UREAD-NCAS, 7.1 PM**: The work charged to the project has been primarily addressing the task: "Efficiently diagnose analyses of M4 HR", the bulk of the work we have done on the other parts of the JRA have been done with other funding. Concerning analyses of M4HR, we have 1) Carried out a significant amount of analysis of the runs, comparing to observations and other resolutions, and in doing so, 2) developed methods for high-performance conservative re-gridding in spherical and cartesian coordinates in the CF-Python tool (using the ESMF regridding libraries).

**DLR, 1.95 PM** on the implementation of CDO-PIO into ECHAM/MESSy; plug-in module for the MESSy CHANNEL interface.

**BSC, 2.92 PM** in analysing and optimizing the NEMO computational performance to make a better usage of computational resources and collaborate with the NEMO System Team to help improving the model by improving the efficiency and the throughput.

**IC3, 6.55 PM** for the assessment report on Autosubmit, Cylc and ecFlow; development of Autosubmit release; Autosubmit-EC-Earth runtime environment.

**Met.no, 2.1 PM** on testing NorESM on PRACE machines; 2PM on optimising and analysing model performance.

**MF-CNRM, 1.02 PM** for I/O performance improvement, still through interfacing the XIOS software.

**KNMI, 0 PM** integration of XIOS in EC-Earth. This activity has been taken over from another EC-Earth partner institute.

**MPG, 5 PM** on performance improvements for CDO and CDI-PIO.

**Corrective actions:** none

# WP10/JRA2: Performance benchmarks for coupled climate models

| Work Package Number | *WP10/JRA2* | | Start Date or Starting Event | | | | Month 1 | |
|---|---|---|---|---|---|---|---|---|
| Work Package Title | Performance benchmarks for coupled climate models | | | | | | | |
| Activity Type | *RTD* | | | | | | | |
| Participant Number | 1 | 2 | 3 | 4 | 6 | 7 | 10 | 12 | 15 |
| Participant Short Name | CNRS-IPSL | DKRZ | CERFACS | CMCC | MetO | STFC | MPG | UNIMAN | LiU |

**Summary of progress of the work package:**

The main objective of WP10/JRA2 is to establish a suite of climate application benchmarks that can be used for benchmarking HPC systems and provide a basis for co-design of future Earth System Models (ESMs) and HPC systems.

During the second reporting period the effort on further development of the ENES Benchmark Suite designed within WP10/JRA2 has been continued. Currently, four ESM benchmarks (**CMCC-CESM-NEMO**, **EC-EARTH**, **IPSLCM**, and **MPI-ESM1**), one atmospheric model benchmark **ICON**, and one computational kernel **tra_adv** (describing tracer advection and extracted from the ocean model NEMO) are available at *https://redmine.dkrz.de/projects/enes-benchmark-suite*. The benchmarks documentation and performance reference are also provided there. For evaluation of couplers, specifications of benchmarks, coding style and standards have been finalised and documented. Sources of coupler benchmarks are shared via Bitbucket platform at *https://bitbucket.org/CouplingBenchmarks* (currently, the code is accessible for members of the development team only). Links to the documentation, performance reference, and download area of prepared benchmarks are collected in the ENES Portal at:
*https://verc.enes.org/computing/performance/benchmarks*.

**Details for each task:**

**Task 2: Suite of base benchmarks**
Following the strategy developed within Task 1 ("Framework and benchmarking guide") during the first IS-ENES2 period, the work on further advancement of the ENES Benchmark Suite has been continued and an interim report produced (**D10.2**).

- The CMCC-CESM-NEMO model has been updated to the latest stable release CESM 1.2.2. The NEMO ocean model has been updated to the NEMO 3.4 release. A performance analysis of the new model has been carried out, evaluating the scalability of the each component. An optimization concerning the communication of the MPI processes involved in the NEMO North fold boundary condition has been integrated. The model has been also evaluated taking into account the metrics for the evaluation of ESMs defined in WP9/JRA1.
- A representative NEMO kernel has been extracted and made available for download, providing also a report including instructions for the execution on HPC systems and related benchmark results on the CMCC iDataPlex system.
- DKRZ and MPG jointly worked on the preparation, update, and performance analysis of MPI-ESM1 and ICON benchmarks.
- CNRS-IPSL continued work related to the IPSL-CM benchmark. CNRS-IPSL benchmark (IPSLCM6-VLR) is available on request for vendors and project partners. Currently, the benchmark runs every two days at two different computing centres (TGCC and IDRIS) for trusting. Checks of restartability, parallel implementation and performance are conducted on a regular basis. The next version, IPSLCM6-LR, is still under development and should be available next year.

- LiU worked on a User Guide for building and benchmarking EC-EARTH and analysed performance of IFS, the atmospheric component of EC-EARTH, on Triolith system at NSC and Beskow Cray XC40 system at PDC.

**Task 3: Evaluation of coupling strategies**
Task 3 focuses on the evaluation of coupling technologies for Earth System Models. In the second reporting period CERFACS, UNIMAN, STFC, and MetO have jointly worked out definitions of the coupling benchmarks and benchmark coding style and standards to be adopted. All details and documents can be found at:
*https://redmine.dkrz.de/projects/isenes2wp10/wiki/Wiki_page_for_WP10_Task_3*. Development of benchmarks for evaluation of widely used couplers (OASIS3-MCT, ESMF, MCT) has been started as described in **MS10.4** produced during the period.

**Significant results:**

**Task 1:**
- Deliverable **D10.1** on the framework for benchmark suite, prepared during RP1 has been completed month 24.

**Task 2:**
- Further development and upgrade of the ENES Benchmark Suite:
  - Benchmark versions of four coupled ESMs (CMCC-CESM-NEMO, EC-EARTH, IPSLCM, and MPI-ESM1) available (**MS10.2**)
  - Extraction of a representative NEMO kernel (**MS10.3**)
  - Benchmark version of ICON available (**MS10.5**)
- Performance analysis of supplied benchmarks on accessible HPC systems
- Publication of available benchmarks, documentation, and performance data at *https://redmine.dkrz.de/projects/enes-benchmark-suite*.
- Publication of Deliverable **D10.2** "Interim report on status of benchmark suite"

**Task 3**:
- Definitions of the coupling benchmarks and benchmark coding style and standards
- International workshop on coupling technologies for Earth System Models in April 2015
- Coding sprint in October 2015 devoted to implementation of the stand-alone components at the base of benchmarks and on the benchmark definition
- Implementation of the benchmark suite for evaluation of coupling strategies (**MS10.4**)

**Deviations from Annex I (DoW):**

n/a

**Reasons for failing to achieve critical objectives and/or not being on schedule**:
None

**Use of resources:**

**CNRS-IPSL, 5.14 PM.** Regular benchmarking of the IPSL model and its components. Reporting on IPSL benchmarking activities. Summary of IPSL benchmark to give feedback from CMIP5 to PRACE infrastructure (computing, data storage, network and facilities).

**DKRZ, 4.1 PM,** DKRZ leads the WP10/JRA2 by participating in project meetings, telephone conferences, and by coordinating the work package activities. It maintains the Redmine Project

Management Tool used for documentation and dissemination of ENES benchmarks and corresponding performance data (*https://redmine.dkrz.de/projects/enes-benchmark-suite*). DKRZ and MPG jointly provided ESM benchmark MPI-ESM1 and atmospheric model benchmark ICON, instructions on execution and evaluation of these benchmarks, and results from performance analysis.

**MPG, 1 PM.** MPG jointly with DKRZ provided ESM benchmark MPI-ESM1 and atmospheric model benchmark ICON, instructions on execution and evaluation of these benchmarks, and results from performance analysis.

**CERFACS, 3.7 PM,** coordinates activities related to the evaluation of coupling strategies, participated in the definition of coupling benchmarks and coding standards and started the implementation of benchmarks based on couplers developed by CERFACS.

**CMCC, 8.01 PM,** updated the CMCC-CESM-NEMO model. The CMCC-CESM-NEMO model has been updated to the latest stable release CESM 1.2.2. The NEMO ocean model has been updated to the NEMO 3.4 release and the optimization of the NEMO North fold boundary condition, developed in WP3/NA2, has been integrated. A performance analysis of the new model has been carried out taking into account the metrics for the evaluation of ESMs defined in WP9/JRA1. A representative NEMO kernel has been extracted and the kernel code has been delivered providing also the documentation on execution and performance analysis. The number of person months is higher than initially planned because figures with a lower monthly rate have been employed.

**MetO, 2.5 PM,** participated in project activities related to evaluation of coupling techniques in Earth system models. However, this partner has not charged personnel cost to the project in this period.

**STFC, 1 PM,** contributed to the definition of the coupling benchmarks and associated coding standards, set-up the repository structure, helped define a distributed development policy and started the implementation of the benchmarks. This work was facilitated by a number of telco's and workshops.

**UNIMAN, 1 PM,** contributed to the definitions of the coupling benchmarks and benchmark coding style and standards to be adopted. This work took place through a number of workshop and telephone conference meetings. UNIMAN also commenced development of specific coupling instances to be included in the benchmark suite. With the agreement of the policy officer, UNIMAN used some of their IS-ENES2 funding to partly support the living costs of a PhD student from September/October 2015 until the end of the project rather than on pms. This affects the final total person months claimed for this workpackage but not the activity.

**LiU, 2.85 PM,** worked on benchmarking of the EC-EARTH 3.2beta version, which is a pre-release CMIP6 version of EC-Earth, and wrote best practice guide for building and benchmarking EC-EARTH.

**Corrective actions:** None

# WP11/JRA3: Developing software infrastructure for data archive services

| Work Package Number | *WP11/JRA3* | | Start Date or Starting Event | | | Month 19 | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Work Package Title** | **Developing software infrastructure for data archive services** | | | | | | | | |
| **Activity Type** | *RTD* | | | | | | | | |
| **Participant Number** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| **Participant Short Name** | **CNRS-IPSL** | **DKRZ** | **CER FACS** | **CMCC** | **UREAD** | **MetO** | **STFC** | **SMHI** | **KNMI** |
| **Participant Number** | **10** | **13** | **15** | **17** | **19** | | | | |
| **Participant Short Name** | **CSAG** | **INHGA** | **LiU** | **UC** | **DMI** | | | | |

**Summary of progress of the work package:**

WP11/JRA3 aims to enhance the existing data archives services of WP8/SA2. During this period a security vulnerability was discovered in the ESGF software system, and the service was taken off-line for an extended period. Substantial effort was then devoted to re-factoring the software to resolve this problem. Nevertheless, key objectives have been met. In all areas, core data services, metadata, support for climate impacts and monitoring, it was possible to make significant advances.

**Details for each task:**

**Task 1: Core data service software development**
Following a security incident in June 2015, the ESGF software stack has been reviewed and modified to fulfil the highest software security standards. In this context CNRS-IPSL and LIU improved the ESGF installation process (builds from GitHub Hook, use standard linux installation package (RPM) when possible, operate ESGF Master repository). CNRS-IPSL improved synda (formerly synchro-data, now the ESGF reference replication software) to support replication requirements, and make it available through RPM. STFC has improved the authentication package for ESGF (moving towards Oauth2), enabling a much smoother user experience. DKRZ improved the data version management in the ESGF publisher, making it more robust and preventing unintended miss-usage of the publication. They also developed a new version of their Quality Control software that includes a separate cf_checker. DKRZ further enhanced the bird house WPS. Birdhouse allows server side computation through a number of predefined process (average, interpolation…). A first integration of the Quality Assurance software has been made in birdhouse. STFC on their side is continuously evaluating ESGF upgrade process, and contributing to ESGF publisher tool and publisher test- suite. STFC implemented quality control tool (ceda_cc) for several major projects (SPECS, CCMI and ESA CCI). **MS11.2** provided an overview of synergies between different implementations of web processing services in the consortium.

**Task 2: Meta-data Services Package**
Within the scope of task 2.1, UREAD contributed to design and implement CIM2 to support CMIP6 (**MS11.3**). CNRS-IPSL refactored and improved the meta programming framework and the tooling associated with the CIM schema. MetO (outside of the contract) contributed to the work on CIM2 and amended their metadata schema to support CIM2. They are starting to populate it with preliminary CMIP6 information prior to participating in testing of CIM2 and pyesdoc. The Medata Entry Tool Evaluation software (**MS11.6**) was released on the github platform.

Within the scope of task 2.2, CNRS-IPSL improved and further enhanced tools available to access CIM information (viewer, comparator, search-api). DKRZ on their side contributed definition of data citation metadata for CMIP6 (early citation info and DataCite metadata). See http://es-doc.org

**Task 3: Data access services for climate impacts**

Within Task 3.1, the climate4impact portal has been upgraded with improvements in search speed, handling of errors related to 3rd party data access, integration of UC downscaling portal, data processing wizard (**MS11.7**), functionality of the data basket (containing search results), flexibility of user authorisation. In addition, many minor problems have been fixed, leading to a significantly enhanced user experience. The data viewer has been integrated into the CLIPC portal and demonstrated at UERRA.

Within Task 3.2, significant work has been done with respect to the on-demand calculation service for climate4impact. Underlying python software package has been developed (*icclim*) and related Web Processing Services (*WPS*) were implemented into climate4impact (**MS11.5**). The second phase of *icclim* development was done in collaboration with the FP7-CLIPC project. Calculations of all ET-CCDI and ET-SCI indices along with standard statistics are now possible on climate4impact. However a better interface is being currently designed and will be implemented within the next reporting period, because the current interface is still only very basic.

**Task 4: Federated archive system monitoring (FASM)**
The implementation of the data usage statistics modules (both coarse- and fine-grain) is the core activity of this period.

The **coarse-grain** module relying on the previously implemented logging mechanisms, has been completed during the period. Tests and security scan of the code are now on-going to certify the module before making it available in the ESGF release. The coarse-grain module is able to provide aggregated statistics regarding: (i) data downloaded (with breakdowns by user, by identity provider and by location); (ii) number of downloads, (iii) number of distinct files, (iv) number of distinct users, (iv) specific views for CMIP5, CORDEX, Obs4MIPs and for all projects, (v) country and continent distributions of past usage. A REST API for programmatic access to the statistics has been also implemented. The access to the user interface has been secured through the ESGF authentication.

During the period, a prototype of the **fine-grain** module, has been also implemented. It includes a cross-project module and a project-specific module. While the former provides information regarding the data downloads occurred over time, data node and project, the latter is more project-specific and gives an in-depth view of the download statistics at the project level. As an example, two views, respectively for CMIP5 and Obs4MIPs, have been implemented; they target different set of attributes/statistics and, at the presentation layer, different views. For CMIP5, several statistics by model, variable, dataset (and version), realm, users, etc. have been included taking into account the requirements collected from climate scientists and gathered during the entire project lifetime. The prototype is now under testing and validation. Several telcos in the context of the ESGF Dashboard-Working Team have been performed for test and validation purposes.

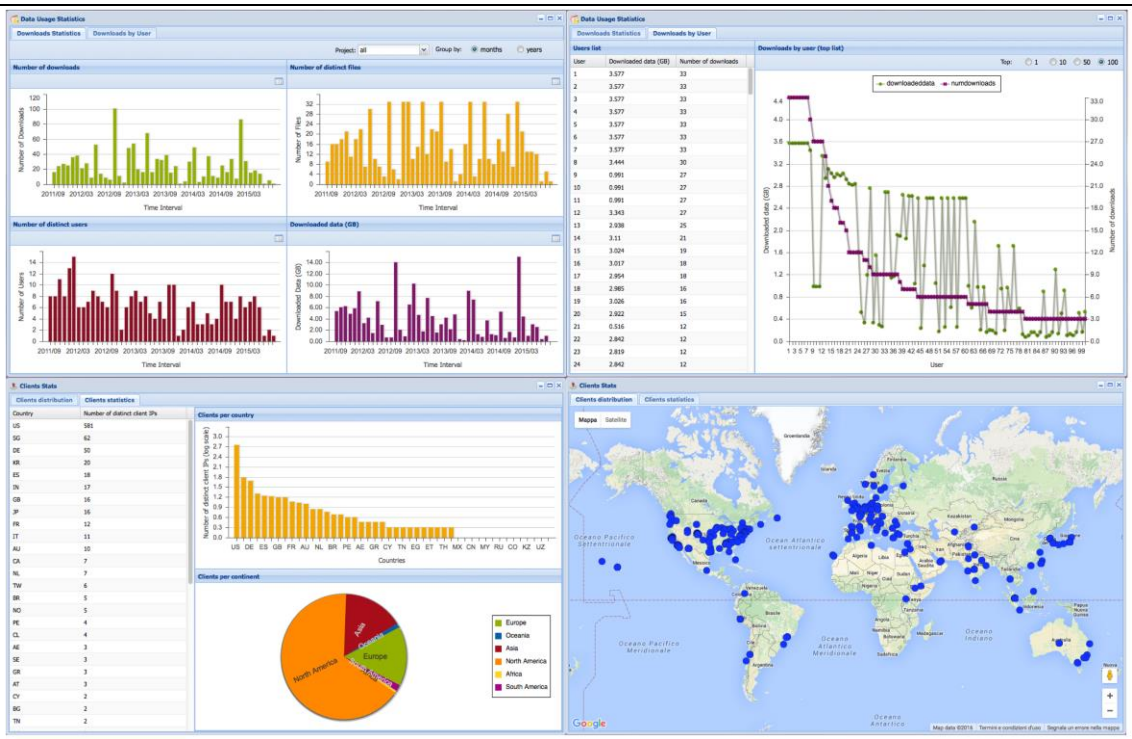


Fig. FASM coarse-grain statistics snapshots

**Significant results:**

**Task 1:**

- LiU and IPSL played a central role defining and implementing the new ESGF software build and deployment process in response to the security incident.
- Joint coordination of and participation in 5th ESGF Conference, December 2015 http://esgf.llnl.gov/media/pdf/2015-ESGF_F2FConference_report_web.pdf
- **MS11.2** was completed in month 26, building on outcomes from the workshop on portals held at KNMI in November 2014.
- **D11.1** (mo 28) provides a clear framework for project delivery.

**Task 2:**

- UREAD and CNRS-IPSL significantly advanced the CIM2 implementation of the entire es-doc stack.
- **MS11.3** (mo 36) provides a new flexible tool for structured metadata creation.
- **MS11.6** (MetO Metadata Entry Tool Evaluation) was reached in February 2015 (mo 23) with the release of the software on the github platform https://github.com/ES-DOC/esdoc-contrib/tree/master/mohc/formatter[3]

**Task 3:**

- KNMI/CERFACS/UC released new Climate4Impact portal version that enhanced the connection with the UC downscaling portal. Also the successive C4I portal version always follows ESGF authentication/authorization evolution (now using oAuth2).
- **MS11.5** (review of requirements for pre-computed products) was completed in month 23.
- The portal includes enhanced processing services (**MS11.7,** mo 26);
- Joint meeting with CLIPC project on portal design, November 2014 (w3id.org/clipc/meetings/debilt_nov2014**)**

3 Documentation for MS11.6 : **http://tinyurl.com/isenes2-ms116**

- **MS11.8** presents a Review of Climate4impact services and objectives and was completed with a one month delay (mo 37) due to ESGF downtime.

**Task4:**

- Coarse-grain statistics module completed
- ESGF Security authentication/authorization added to the FASM module
- First prototype of the fine-grain statistics module available for test and validation
- Contribution to the ESGF Implementation plan regarding the FASM module and the Dashboard-Working Team

**Deviations from Annex I (DoW):**

**D11.3** (Task 4, mo 36) "Report on service monitoring and dashboard (CMCC)" has been moved from mo 36 to mo 46, since the activity on the node-manager (strongly linked to the FASM modules) has been significantly delayed on PCMDI side affecting the implementation plan on the FASM module too.

The security issue experienced in 2015 has required some changes in the implementation plan and priorities The implementation of parallel file download protocol for users has not been advanced and may be not be implemented, though improved support for parallel file transfers between archive nodes is progressing well. Support for extended use by the CORDEX community was achieved in the supplier community, but could not be delivered to the user community while the archive was off-line. **MS11.8** has been delayed by one month, also as consequence of ESGF non-availability.

**MS11.6** (task 2, due mo 21) was completed 5 months late, allowing time for the ES-DOC programming interface to become mature.

**Reasons for failing to achieve critical objectives and/or not being on schedule**:

Critical objectives have been achieved despite the issues described above.

**Use of resources:**

**CNRS-IPSL, 11.87 PM:** Co-leadership of WP. Co-leading the ESGF Installation Working Team, acting as an ESGF release manager and developing the ESGF test suite. Designing and developing a large portion of the es-doc software ecosystem.

**DKRZ, 7 PM**: Work on developing the Bird-House WPS solution and enhancing his ESGF interoperability. Enhance quality control related software.

**CERFACS, 5.9 PM:** Further developments of the icclim indices and indicators calculation software have been done to support on-demand derived products in the climate4impact portal.

**CMCC, 12.70 PM**: development of the FASM (coarse and fine grain modules with security extensions and REST API), test and validation activities. Participation to the ESGF IWT. Leading of the ESGF Dashboard-WT. (Task 4). The number of person months is higher than initially planned because figures with a lower monthly rate have been employed.

**UREAD, 8.8 PM:** Design and implementation of CIM2 (Task 2)

**MetO, 4.3 PM**: Work on CIM2 schema and aligning their own metadata with CIM (Task 2)

**STFC, 4.65 PM:** Leadership of WP, preparation of the delivery plan (delayed to accommodate timetable of changes at PCMDI). Improved ESGF authentication package; ESGF testing; quality control configuration for SPECS, CCMI, ESA CCI (Task 1)

**SMHI, 0.73 PM:** Work on bias corrected CORDEX data: code development, production of bias-corrected data and test publishing on SMHI data node as CORDEX-Adjust, aiming for release in August 2016 on ESGF. Work done jointly with CLIPC.

**KNMI, 7.34 PM:** Climate4impact portal development work (Task 3).

**CSAG, 3.52 PM:** Work on developing derived data products for users. Prototype python code for producing derived products applied to early CORDEX data and other independent downscaled data and tested with users through the UCT/CSAG Climate Information Platform.

**INGHA, 10.06 PM,** Finalised the design for the Danube River Basin case studies, worked on the design and implementation of specific hydrological models and tools for case studies.

**LIU, 5.43 PM,** Co-lead with CNRS-IPSL the development of the ESGF installer.

**UC, 21,5 PM**: Integration of downscaling portal into climate4impact portal (Task 3).

**DMI, 1.65 PM**: Quality control, task 1.4, applying the DKRZ tool to data held at DMI and provided feedback on bugs and results.

**Corrective actions: none**

# Project Management Report

During the second reporting period, the Coordinator, with the assistance of the European Project Manager, ensured the management tasks such as the day to day management, the organisation of meetings, the communication between the European Commission and the Beneficiaries, the management of the budget and the dissemination of the information related to the project. The Coordinator, helped by the European Project Manager and the ENES scientific officer, also ensured the scientific coordination of the project as described in the Annex I of the Grant Agreement and the answers to the Mid-Term Review.

The mid-term review has been an important opportunity to revisit the ENES portal, which provides access to the IS-ENES services. The IS-ENES website (https://is.enes.org) continues to serve to share information about events, deliverables, complemented by an intranet space where partners can share all work documentation, in order to ensure a fruitful collaboration, using the Redmine project management web application.

The mid-term review was also instrumental to help us derive a set of measurable KPIs. A first set was provided in October 2015, to be updated at every six months. The next report will be provided in June 2016, taking into account service results presented in this report.

At last, the Management Team coordinated the reporting of the project from the beginning of March 2016 until the end of May 2016.

## Overall Management and scientific coordination of the Project

*The Second General Assembly*

The IS-ENES2 Second General Assembly (**MS1.4**), held in Hamburg from 16th to 18th of February, has been organised with the help of the associated partner CSC. This location was chosen in order to have a common workshop of a half-day with experts on climate impacts gathered by CSC for a CLIPC workshop. This was an opportunity to advertise our services to a wider community.

Most Beneficiaries were represented with 45 participants from 21 partners. Unfortunately DLR, UNIMAN and CSAG were unable to attend. Aims of this meeting were to share results of the second period, discuss future plans beyond IS-ENES2 and interact with representatives of the climate impact and climate services communities.

The General Assembly showed a general good progress of the work and provided all partners an overall vision of the activities. It helped to prepare the second period report and the work of the next period. It was also an opportunity to discuss long-term sustainability of the infrastructure and future plans beyond IS-ENES2.

Presentations given during the second general assembly meeting can be found at:

https://verc.enes.org/ISENES2/events/is-enes2-second-general-assembly

*Management and scientific coordination of the Project:*

The management and the scientific coordination of IS-ENES2 have been ensured by the Executive Board, composed by the work packages Leaders/Co-leaders and the Management Team. During the period, the Coordinator, helped by the European Project Manager, has organised and chaired 6 WPL teleconferences and two face-to-face meetings, one at the mid-term review and one at the second general assembly, gathering the Executive Board during the second period of the project. Minutes of these teleconferences are archived on the Redmine platform (internal collaboration).

These teleconferences usually include a first part dedicated to the debriefing of work packages by the WPLs, followed by one or various sessions dealing with consortium management issues (general

information on the project, organisation of meetings, announcement of meetings of general interest for the project and the community) as well as on strategic issues such as the international governance of ESGF, the preparation of a long-term infrastructure for IS-ENES and the synergies between IS-ENES2 and the newly set Centre of Excellence on HPC for Climate and Weather, ESiWACE.

The role of the Management Team was to disseminate information on the project, to be sure that Work Package Leaders respected the work plan and the timeline of IS-ENES2, and to propose corrective actions if necessary.

*The reporting of the project:*

Work Package Leaders sent their contributions for the scientific report (work package report, deliverables and milestones due to the Period 2) by mid April 2016. These documents were collected by the European Project Manager. The Coordinator reviewed the work package reports, commented them and asked for corrections to have a final version by mid-May. The European Project Manager coordinated the financial reporting to have all the Form Cs on FORCE by the end of April 2016 with the Use of Resources table of each Beneficiary.

The European Project Manager also gathered all deliverables and milestones. Each deliverable is reviewed by at least two Work Package Leaders or co-leaders not involved in the work prior to the final publication of the deliverable on the IS-ENES2 website.

The Coordinator wrote the Publishable summary, the Project objectives for the period and Project management report. The European Project Manager had to upload all the required information on the SESAM platform.

## Communication

*Website:*

The IS-ENES2 dedicated website (http://is.enes.org/) was set up by DKRZ (Beneficiary 2), and CNRS-IPSL (Beneficiary 1). It was launched in July 2014.The content management system used is Plone.

The website presents the project, its aims and objectives and gives a short description of each work package. It also provides the list of beneficiaries with a short description. A section of the website is dedicated to the project management and provides some information on the organisational structure of the Consortium. The IS-ENES2 website also provides access to resources such as the model and data services (link to the ENES portal, central point of entry to these services).

Visitors can find news about the project and information about the IS-ENES2 meetings.

The “documents” folder offers the possibility to visitors to download documents related to the project.

The IS-ENES2 website has a specific folder in which all content related to the first phase of the IS-ENES project is gathered.

At last the folder “Internal” provides information about how to access the collaboration area.

*Newsletter*

A newsletter has been elaborated by the European Project Manager, with contributions from the ENES Scientific Officer, and started in January 2015. When possible it is sent monthly. Due to technical problems it has stopped for a few months but will be launched again starting June 2016. It provides information on IS-ENES2 results as well as other issues related to climate modelling infrastructure. It is sent to 150 people.

*Talks about IS-ENES given during the second period:*

During the second reporting period the Coordinator, work package Leaders and Partners have given talks on IS-ENES2 or have participated to poster sessions. Please find below the list of talks about the project given during this period:

***Publications on work done within IS-ENES2 by the partners***

*Reviewed publications on IS-ENES published during the second period:*

Rousset C., M. Vancoppenolle, G. Madec, T. Fichefet, S. Flavoni, A. Barthélemy, R. Benshila, J. Chanut, C. Levy, S. Masson, and F. Vivier: The Louvain-La-Neuve sea ice model LIM3.6: global and regional capabilities. Geosci. Model Dev., 8, 2991-3005, doi: 10.5194/gmd-8-2991-2015, 2015

Valcke S., A. Craig, R. Dunlap, and G. D. Riley, 2016. Sharing experiences and outlook on Coupling Technologies for Earth System Models, Bull. Amer. Meteor. Soc., March 2016, doi:10.1175/BAMS-D-15-00239.1

*Reviewed publication published during the first period (omitted in RP1 report):*

R. Dunlap, M. Vertenstein, S. Valcke, and T. Craig, Second Workshop on Coupling Technologies for Earth System Models, Bull. Amer. Meteor. Soc., 95, ES34–ES38, 2014, doi:10.1175/BAMS-D-13-00122.1

*Accepted for publication:*
Epicoco et al. « Hybridisation Strategies and Data Structures for the NEMO Ocean Model », to appear in the International Journal of High Performance Computing

*Technical reports:*

Valcke S., T. Craig and L. Coquart, OASIS3-MCT User Guide, OASIS3-MCT_3.0, TR/CMGC/15/38, Technical Report URA CERFACS/CNRS No1875, may 2015.
http://www.cerfacs.fr/oa4web/oasis3-mct_3.0/oasis3mct_UserGuide.pdf

Maisonnave, E., Coquart, L., Fladrich, U., Fogli, P.-G.., Hill, R., Seland, O., Voldoire, A., 2016: Mise à jour des interfaces dans les modèles IS-ENES pour compatibilité avec le nouveau coupleur OASIS Rapport technique, **TR/CMGC/16/29506**, CECI, UMR CERFACS/CNRS No5318, France
http://cerfacs.fr/wp-content/uploads/2016/03/GLOBC-MAISONNAVE-TR-oasis_compliance.pdf

***Oral and poster communications on work done within IS-ENES2 by the partners***

**2014**

Denvil S., CORDEX and IS-ENES, 2014 ESGF F2F, San Francisco, December ***9-11,*** 2014, **Oral**
http://aims-group.github.io/pdf/f2f2014/cordex_is-enes.pdf

Denvil S., Modeling groups and Data Center Requirements. Session's Keynote, 2014 ESGF F2F, San Francisco, December ***9-11,*** 2014, **Oral**
http://aims-group.github.io/pdf/f2f2014/modeling_data_center_reqs.pdf

Dwarakanath P. , P. Lundquist, System for off-line data access, 2014 ESGF F2F, San Francisco, December ***9-11,*** 2014, **Oral**
http://aims-group.github.io/pdf/f2f2014/soda.pdf

Foujols M.A., S. Joussaume, Y. Meurdesoif, Climate modeling : IPSL climate model, HPC challenges, European cooperation and opportunities for collaboration, 2nd Joint Laboratory for extreme scale computing meeting, Chicago, USA, 24-26 November 2014. **Oral**
http://dods.ipsl.jussieu.fr/mafoipsl/EXPOSES/2014/JLESC-FOUJOLS.pdf

http://presentations.copernicus.org/EMS2014-265_presentation.pdf

Greenslade M., ES-DOC, 2014 ESGF F2F, San Francisco, December ***9-11,*** 2014, **Oral**
http://aims-group.github.io/pdf/f2f2014/ES-DOC.pdf

Kinderman S., S. Wiegel, Versioning and replication working group, 2014 ESGF F2F, San Francisco, December ***9-11,*** 2014, **Oral**
http://aims-group.github.io/pdf/f2f2014/versioning_replication_wg.pdf

Page C. et al., Providing and facilitating climate model data access in Europe: IS-ENES and CLIPC initiatives, EMS/ECAC 2014, Prague, Czech Republic, 6-10 October 2014, **Oral**

Plieger M. et al., Bridging CMIP5 and CORDEX data infrastructure to impact users, 2014 ESGF F2F, San Francisco, December ***9-11,*** 2014, **Oral**
http://aims-group.github.io/pdf/f2f2014/climate4impact_cmip5_cordex.pdf

**2015**

Berger K., G. Levavasseur, M. Stockhause, M. Lautenschlager, Integration of external metadata into the Earth System Grid Federation (ESGF), EGU 2015, April 2015, **Poster**
http://meetingorganizer.copernicus.org/EGU2015/EGU2015-8404.pdf

Dwarakanath P., N. Carenton, ESGF Installation working team, 2015 ESGF F2F Monterey, USA, December ***8-11,*** 2015, **oral**
http://esgf.llnl.gov/media/2015-F2F/Presentations/Prashant-D.-iwt.pdf

Dwarakanath P., Software security working team, 2015 ESGF F2F Monterey, USA, December ***8-11,*** 2015, **oral**
http://esgf.llnl.gov/2015-F2F.html#

Greenslade M. et al., Earth system documentation (ES-DOC) preparations for CMIP6, 2015 ESGF F2F Monterey, USA, December ***8-11,*** 2015, **Oral**
http://esgf.llnl.gov/media/2015-F2F/Posters/Earth-System-Documentation-%28ES-DOC%29-Preparations-for-CMIP6.pdf

Joussaume S., European climate modelling infrastructure: Accessing climate projections, Copernicus C3S Climate Data Store Workshop, Reading, UK, 3-6 March 2015 **- Oral**
http://www.ecmwf.int/sites/default/files/elibrary/2015/13552-european-climate-modelling-infrastructure-accessing-climate-projections.pdf

Joussaume S., Access to CMIP climate projections: strengths, weaknesses & perspectives, Copernicus C3S Projection Workshop, Reading UK, 20-21 April 2015 **– Oral**
http://www.ecmwf.int/sites/default/files/elibrary/2015/13505-access-cmip-climate-projections-strengths-weaknesses-perspectives.pdf

Joussaume S., Infrastructure for the European network for Earth system modelling, SeRC 6TH Annual Meeting, Stockholm, June 15th 2015 **- Oral**

Joussaume S., Data and computing infrastructures for climate modelling**,** Research Data Alliance 6th Plenary meeting, Paris, September 22, 2015 - **Oral**
https://is.enes.org/documents/presentations/rda-sixth-plenary-meeting/data-and-computing-infrastructures-for-climate-modelling/view

Joussaume S., HPC for CMIP6 and beyond, PRIMAVERA-CRESCENDO Workshop, Exeter, UK, 24-25/11/2015 – **Oral**
https://www.primavera-h2020.eu/primavera/static/media/uploads/Meetings/KO_Meeting_Exeter_24Nov2015/Presentations/tue_8_151124_hpc_joussaume.pdf

Kershaw P. et al., Identity entitlement access team, 2015 ESGF F2F Monterey, USA, December ***8-11***, 2015, **Oral**

Kindermann S. et al., replication and versioning working team, 2015 ESGF F2F Monterey, USA, December ***8-11***, 2015**, oral**
http://esgf.llnl.gov/2015-F2F.html#

Levavasseur G. et al., CMIP6 errata as a new ESGF service, 2015 ESGF F2F Monterey, USA, December ***8-11***, 2015, **Oral**

Manubens D., J. Vegas, F. Doblas-Reyes, Autosubmit: a versatile tool to manage weather and climate experiments in diverse supercomputing environments, EC-Earth meeting, Reading, UK, May 5th 2015, **Poster**
https://earth.bsc.es/wiki/lib/exe/fetch.php?media=library:external:20150506_jvegas_ec-earth2015.pdf

Nassissi P., S. Fiore, G. Aloisio, ESGF dashboard working team, 2015 ESGF F2F Monterey, USA, December ***8-11***, 2015, **Oral**
http://esgf.llnl.gov/media/2015-F2F/Presentations/Dashboard.pdf

Page C., N. Tatarinova, M. Plieger, W.S. de Cerff, A. Cofiño , M. Vega, climate4impact: a tailored IS-ENES web portal providing processing and downscaling services through WPS and interfaced with icclim/ocgis, GO-ESSP 2015 Workshop, Abington UK, 24-25 February 2015, **Oral**
http://go-essp.gfdl.noaa.gov/2015/presentations/P1_CPage_ISENES_GO_ESSP_2015.pdf

Page C., Climate4impact in IS-ENES2, CLIPC 2nd General Assembly, Dortmund, Germany, 2-3 June 2015 **- Oral**

Page C. et al., A user friendly portal to give access to climate scenarios and prediction data, SPECS Fourth General Assembly, 15-17 September 2015 - **Oral**
https://is.enes.org/documents/presentations/scpecs-4th-ga/

Plieger M. et al., Application of open source standards and technologies in the http://climate4impact.eu/ portal, PICO Spot 1 at EGU 2015, April 15th 2015, **Poster**
http://meetingorganizer.copernicus.org/EGU2015/EGU2015-10063.pdf

Plieger M. et al., The climate4impact portal: bridging the CMIP5 and CORDEX data infrastructure to impact users, ESSI2.1 Digital infrastructures to enhance international geoscience information access, provision and use, April 17th 2015**, Oral**
http://meetingorganizer.copernicus.org/EGU2015/EGU2015-9721.pdf

Plieger M. et al., Climate4impact portal, 2015 ESGF F2F Monterey, USA, December ***8-11,*** 2015, **Poster**
http://esgf.llnl.gov/media/2015-F2F/Posters/Bridging-SPECS-CMIP5-and-CORDEX-data-to-impact-users.pdf

Rathmann T., User support working team, 2015 ESGF F2F Monterey, USA, December ***8-11,*** 2015, **oral**
http://esgf.llnl.gov/media/2015-F2F/Presentations/User-Support-Working-Team.pdf

Som de Cerff et al. The IS-ENES climate4impact portal: bridging the CMIP5 and CORDEX data to impact users, EGU 2015, April 2015. **Poster**
http://meetingorganizer.copernicus.org/EGU2015/EGU2015-8697.pdf

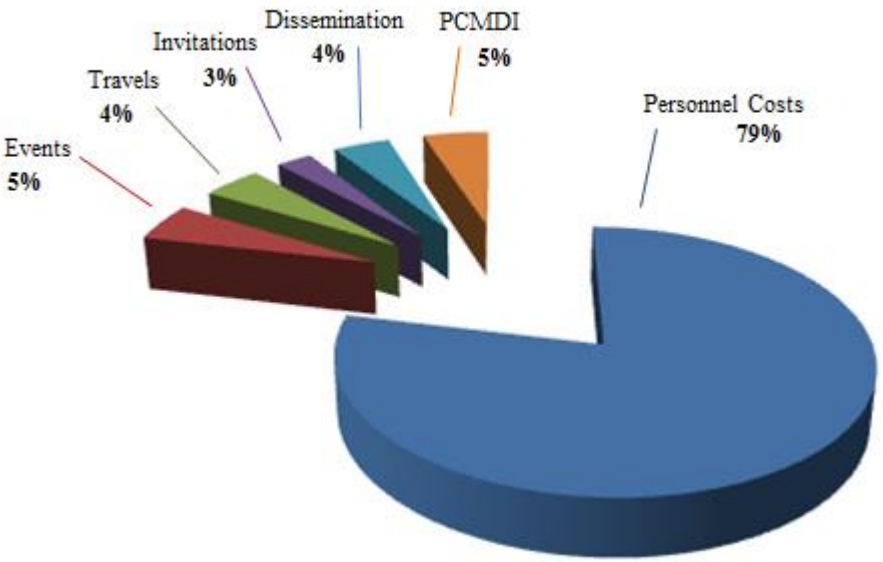
Torsten R., F. Toussaint, S. Kindermann, M. Lautenschlager, Support to Climate Data Dissemination in a Worldwide Data Federation by IS-ENES2 , EGU 2015, April 2015, **Poster**
https://www.dkrz.de/pdfs/poster/EGU2015_SupportByISENES_Rathmann09.pdf?lang=de

Wilson S., An Investigation of the Timestep of three Atmospheric Models, NCAS Science Conference, York, 2015, **Poster**
http://cms.ncas.ac.uk/attachment/wiki/AboutCMS/PresentationsAndReports/SSW_York.pdf

**2016**
Joussaume S., Earth system complexity, Advancing the climate modelling enterprise in Europe, Chicheley Hall, UK, January 11-12 2016 **- Oral**

Page C., S. Joussaume, M. N. Juckes, W. S. de Cerff, M. Plieger, L. Barring, M. Kolax, R. Hutjes, F. de Jong, E. Bucchignani, N. Tatarinova, A. Cofiño, and E. de Vreede, climate4impact: Providing, tailoring and facilitating climate model data access, AMS 2016, New Orleans, LA, USA, 11-14 January 2016 - **Oral**
https://ams.confex.com/ams/96Annual/webprogram/Paper282659.html

## WP1 use of resources




*Staff efforts:*

CNRS-IPSL (Beneficiary 1) devoted **20.21 person months** (PMs) for the management of the project. The Coordinator spent **2.21 PMs** on the overall management and scientific coordination of the project for the first 18 months. The European project manager, paid by IS-ENES2, spent **18 PMs** in order to assist the coordinator in their tasks.

*Organisation of events:*

As mentioned in the previous periodic report, due to delays of reimbursement procedure, costs related to the organisation of IS-ENES2 First General Assembly are affected to this period (RP2), although the meeting took place within period 1, as planned in the Annex I of the Grant Agreement.

The first General Assembly meeting cost was 4 359, 5€.

For the same reasons, costs related to IS-ENES2 second general Assembly will be affected to the last period of the project, although the meeting took place in February 2016, hence during this period.

Also due to delays of reimbursement procedure, RP2 financial report includes the costs associated to the the organisation of the July 2014 Heathrow preparatory meeting for the establishment of the climate and weather Centre of Excellence, which now exists under the name ESiWACE (H2020 project: https://www.esiwace.eu/) (1 403, 48€).

*Travels:*

4 811.43€ of the total direct costs were devoted to WP1 travels, essentially to attend the project Mid Term Review in Brussels, as well as the second General Assembly in Hamburg, and participate to events to promote the project.

*Invitations:*

During this period, invitations of expert scientists from the community represent a negligible part of the total direct costs incurred in this work package, associated with only 2 open workshops during this period. The first one on Coupling technologies did not require additional funding for its invitations. For the second one, the 2nd General Asssembly, we opened it and invited external expert scientists, but they could not attend unfortunately. However, Peter Bauer from ECMWF, attended through videoconference (no costs incurred), to participate to our discussion on the Strategy. It is also worth mentioning the invitation of Dimitra Konsta, as part of WP3 activity on COSP improvement (related cost: 294, 33€).

*Dissemination*

In the second period, 4 615, 37€ were spent on dissemination activities. This includes setting up of a web Banner of the project (with logo) on the Climate Action page of www.horizon2020projects.com website for a 3 months period (November 2014 to January 2015), 2 articles about the project in the Science & Technology journal, (one to be published in the course of 2016 and one in 2017), and supporting the mission of Christian Pagé (CERFACS) to the European Meteorological Society annual meeting, during which he presented the Climate4Impact portal.

*PCMDI (USA)*

A budget of 55 k€ was initially planned for collaboration with the USA.

During the second period:

- 5 300,1€ were spent on this budget line to support P. Dwarakanath's visit (from Linkoping University) to PCMDI in December 2014, to work on the collaborative development of the ESGF Node Manager.

Other expenses were engaged on this budget line during the second period, which will be reported in the RP3 financial report:

- P. Dwarakanath's second visit to LLNL-PCMDI in December 2015, to pursue the work on ESGF Node Manager.
- The invitation of Allyn Treshansky (NESII/CIRES/NOAA) and Chris Blanton (NOAA/Princeton) to the IS-ENES2 workshop on ES-DOC/CMIP6, which was organised in Abingdon in March 2016.

## List of Project Meetings

| Dates | Meeting | Venues |
|---|---|---|
| September 29th 2014 | Climate and weather Centre of Excellence preparatory meeting | Reading (UK) |
| November 17-19th 2014 | IS-ENES2-CLIPC joint workshop on Design of scientific portals | De Bilt (NL) |
| March 20-25th 2015 | Master class on the use of climate services, following the prototype design piloted at WU with 48 Academic Consultancy Training students | Wageningen (NL) |
| March 25th 2015 | IS-ENES2 Mid-Term Review | Brussels (BE) |
| April 1st-3rd 2015 | IS-ENES2 Climate4impact Coding Sprint | De Bilt (NL) |
| April 20-22nd 2015 | 3rd Workshop on Coupling Technologies for Earth System Models | Manchester (UK) |
| October 13-15th 2015 | Birdhouse / Web Processing Service Joint Workshop | Paris (FR) |
| December 7-11th 2015 | IS-ENES2 side meeting at 5th Annual Earth System Grid Federation Face-to-Face Conference | Monterey (USA) |
| December 15-17th 2015 | IS-ENES2 Climate4impact Coding Sprint | De Bilt (NL) |
| January 13th 2016 | Ad hoc meeting on portable interfaces with Bjorn Stevens (MPI-M) when visiting the Met Office for a seminar. | Exeter (UK) |
| February 2016 | Workshop on Configuration Management in Climate Science - various virtual meetings through February | Virtual |
| February 13th 2016 | Meeting with J. Bessembinder (KNM) on collaboration on climate service trainings with the EUSTACE project | Wageningen (NL) |
| February 10-12th 2016 | CLIPC/IS-ENES2 joint workshop on Common CVs for climate indices | Toulouse (FR) |
| February 17th 2016 | CLIPC/IS-ENES2 joint session during IS-ENES2 second General Assembly | Hamburg (DE) |
| February 16-18th 2016 | IS-ENES2 Second General Assembly | Hamburg (DE) |
| March 08-11th 2016 | IS-ENES2 ES-DOC 2016 Workshop | Abingdon (UK) |
| March 18-24th 2016 | Master class on the use of climate services - Academic Consultancy Training | Wageningen (NL) |

## Use of Staff Effort per Beneficiary during the second reporting period

| *WP* | WP1 | | | WP2 | | | WP3 | | | WP4 | | | WP5 | | | WP6 | | | WP7 | | | WP8 | | | WP9 | | | WP10 | | | WP11 | | | Total per Beneficiary | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 | DoW | RP1 | RP2 |
| **CNRS** | 54 | 16 | 20,2 | 29 | 3,78 | 19,26 | 12 | 1,19 | 1 | 4 | 0,84 | 3,56 | 3 | 1,38 | 3,42 | 5 | 0,35 | 1,78 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 1,81 | 14,31 | 11 | 4,88 | 5,14 | 21 | 2,83 | 11,87 | **158** | **33,07** | **80,55** |
| **DKRZ** | 0 | 0 | 0 | 24 | 4,5 | 3,7 | 9 | 1 | 2 | 7 | 5,1 | 2,3 | 12 | 0 | 5,1 | 4 | 1,4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 3,3 | 2 | 18 | 5,9 | 4,1 | 20 | 13 | 7 | **106** | **34,2** | **26,2** |
| **CERFACS** | 0 | 0 | 0 | 2 | 1 | 1,5 | 0 | 0 | 0 | 11 | 7 | 4,9 | 18 | 5,3 | 14 | 2 | 1 | 0 | 4 | 2 | 0,9 | 0 | 0 | 0 | 25 | 7 | 14,7 | 9 | 1 | 3,7 | 24 | 13 | 5,9 | **95** | **37,3** | **45,6** |
| **CMCC** | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 12,8 | 8,01 | 3 | 0 | 0 | 4 | 0 | 0,79 | 2 | 0 | 4,55 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0,4 | 2,56 | 12 | 2,3 | 8,01 | 21 | 16,3 | 12,7 | **60** | **31,8** | **36,62** |
| **UREAD** | 0 | 0 | 0 | 8 | 1,1 | 5,1 | 12 | 0 | 5,8 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 7,1 | 0 | 0 | 0 | 21 | 0 | 8,8 | **59** | **1,1** | **26,8** |
| **MetO** | 0 | 0 | 0 | 2 | 0 | 0,7 | 12 | 5,4 | 4,2 | 12 | 9,6 | 0,2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 4 | 10,5 | 11 | 2,9 | 2,5 | 6 | 0 | 4,3 | **56** | **21,9** | **22,4** |
| **STFC** | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0,98 | 1,81 | 0 | 0 | 0 | 2 | 3,38 | 2,29 | 2 | 0,4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 18 | 16,93 | 4,65 | **30** | **21,69** | **9,75** |
| **SMHI** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0,66 | 2,02 | 3 | 0,93 | 1,34 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 6,18 | 6,94 | 0 | 0 | 0 | 8 | 3,53 | 0,73 | **39** | **11,3** | **11,03** |
| **KNMI** | 0 | 0 | 0 | 2 | 0,296 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 3,1 | 1,28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 2,3 | 0 | 0 | 0 | 0 | 20 | 8,648 | 7,34 | **35** | **14,344** | **8,62** |
| **MPG** | 0 | 0 | 0 | 3 | 0 | 0 | 14 | 4 | 0 | 6 | 2,7 | 3,3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 3 | 5 | 3 | 2 | 1 | 0 | 0 | 0 | **34** | **11,7** | **9,3** |
| **CSAG** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 2 | 5,21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 3 | 3,52 | **29** | **5** | **8,73** |
| **UNIMAN** | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 7 | 0 | 0 | 0 | 4 | 1,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 3,5 | 1 | 0 | 0 | 0 | **14** | **7** | **8** |
| **INHGA** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 3,75 | 10,06 | **15** | **3,75** | **10,06** |
| **WU** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 4,3 | 1,84 | 8 | 0 | 2,77 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **16** | **4,3** | **4,61** |
| **LiU** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 1,94 | 2,85 | 7 | 1,88 | 5,43 | **13** | **3,82** | **8,28** |
| **BSC** | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 6,3 | 4,17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 2,92 | 0 | 0 | 0 | 0 | 0 | 0 | **16** | **6,3** | **7,09** |
| **UC** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 3 | 5,25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 6 | 21,5 | **12** | **9** | **26,75** |
| **DLR** | 0 | 0 | 0 | 6 | 1,78 | 0,78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1,95 | 0 | 0 | 0 | 0 | 0 | 0 | **10** | **1,78** | **2,73** |
| **DMI** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1,22 | 0,78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 3,13 | 1,65 | **9** | **4,35** | **2,43** |
| **IC3** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 6,37 | 6,55 | 0 | 0 | 0 | 0 | 0 | 0 | **11** | **6,37** | **6,55** |
| **MF-CNRM** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1,99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 4,39 | 1,02 | 0 | 0 | 0 | 0 | 0 | 0 | **8** | **4,39** | **3,01** |
| **UiB** | 0 | 0 | 0 | 6 | 0 | 4 | 0 | 0 | 0 | 3 | 1 | 0,56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **9** | **1** | **4,56** |
| **met.no** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0,7 | 2,1 | 0 | 0 | 0 | 0 | 0 | 0 | **6** | **0,7** | **2,1** |
| **TOTAL** | **54** | **16** | **20,2** | **82** | **12,46** | **35,04** | **91** | **33,7** | **33,99** | **46** | **26,2** | **14,8** | **93** | **25,8** | **44** | **28** | **4,08** | **10,4** | **4** | **2** | **0,9** | **0** | **0** | **0** | **151** | **39,5** | **77,65** | **82** | **24,42** | **29,3** | **209** | **92** | **105,5** | **840** | **276,16** | **371,8** |
| **REMAIN** | **17,78** | | | **34,504** | | | **23,34** | | | **4,94** | | | **23,19** | | | **13,48** | | | **1,1** | | | **0** | | | **33,9** | | | **28,28** | | | **11,552** | | | **192,066** | | |
| **% of Use** | **67%** | | | **58%** | | | **74%** | | | **89%** | | | **75%** | | | **52%** | | | **73%** | | | **n/a** | | | **78%** | | | **66%** | | | **94%** | | | **77%** | | |

## Budget reallocations

### 1- Transfers

- **Transfer of activity from one partner to the other:**

For practical reasons, it was agreed to proceed to a **direct transfer of 64 200€ (EU funding) from UREAD-NCAS to MPI-M**, corresponding to the reallocation of the 3rd ENES Summer School funds (WP2 - Task 3). The reallocated money should be used by MPI-M to pay invoices sent from University of Helsinki, hosting institution, which took care of booking hotel rooms, catering and all logistic items of the school. This will avoid loss due to currency exchange. A formal letter of agreement was signed by authorised representatives of involved parties (CNRS-IPSL as coordinator, UREAD-NCAS and MPG), after they received approval from the European Commission.

**Transfer of 64 200€ (EU funding) from UREAD-NCAS to MPI-M** for the 3rd ENES summer school

- **Transfers internal to partners:**

**WU WP6**: An internal budget reallocation is needed by WU within WP6, with reduced personnel costs, and increased direct costs shifted to support workshop (master class) organizational costs, and more specifically the reimbursement of SMEs' costs for participation. Indeed, WU had difficulties to get SME representatives to follow the master class on the use of climate services; thus WU proposes to offer participants the reimbursement of costs for participation, expecting this will motivate SME people to come and follow the course. This shift represents 15 000€ (16 050€ in EU funding). This shift will not affect the Grant Agreement, as the work will be carried out as foreseen in Annex I.

**WU internal transfer of 16 050 € EU funding from personnel to other direct costs in WP6/NA5**

**DKRZ, shift from WP3 and WP9 to WP11**: Some internal budget shift has been agreed by the Coordinator for DKRZ with a reduced cost of both the networking activity of WP3/NA2 (3 pm, representing a total EU funding of 17 655€) and of the R&D activity of the WP9/JRA1 (3 pm, representing a total EU funding of 19 800€), to be shifted to WP11/JRA3 (5.6 pm, representing 37 455€), to support more work to be done on task 1.4 (Quality control work-flow and tools) for adapting the quality control tool to the new CMIP6 agreements and protocols. This additional resource was proposed because currently the CMIP6 specifications with respect to e.g. naming conventions, controlled vocabularies are being finalized and it would be a large benefit to the community to include these CMIP6 specifications into a new release of the DKRZ QA tools, such that the tool is ready for modelling groups to check their CMIP6 data submissions or CMIP6 test runs (which will start late this year). This shift will not affect the Grant Agreement as the work will be carried out as foreseen in Annex I thanks to synergies in WP3 and WP9 with other (internal) projects.

**DKRZ internal transfer of 37 455 € EU funding from WP3/NA2 (17 655 €) and WP9/JRA1 (19 800 €) to WP11/JRA3**

### 2 - Other budget reallocations:

Some beneficiaries need to readjust their costs for some activities. This concerns some of the coordination costs, which could be reduced, the maintenance of the ENES portal, which requires less than planned, and some activities of our South African partner, which were overestimated. However, these readjustments do not affect the work as foreseen in the DoW. Moreover, this offers some possible reallocation possibilities to other activities that are important for IS-ENES2.

**Money released to the consortium**

- **CNRS:**

**WP1 envelope on cooperation with USA** (55k€ direct cost) will not be entirely spent.
So far , activities supported in RP1 and RP2 as well planned in RP3 represent a total amount of 30 k€.
We anticipate another 15 000€ to be spent on supporting two more visits in the last period of the project, which are still being discussed.
**Therefore CNRS-IPSL can release 10 000€ direct cost to the consortium from WP1, i.e. 16 000 € EU funding**

**WP1 organisation of meetings** (initial envelope 60k€ direct cost): project Kick-Off and the first two General Assemblies were cheaper than expected. So far we have spent 25 000€ on the organisation of these 3 meetings.
We want to keep the initial budget of 15 000€ for the last GA and 15 000€ are anticipated to support the organisation of other important meetings, such as the ENES strategic foresight update meeting (to be organised in the fall of 2016).
**Therefore CNRS-IPSL can release 5 000€ direct cost to the consortium WP1, i.e. 8000 € EU funding.**

**Total available from CNRS: 15 000€ direct costs representing 24 000€ in EU funding**

- **DKRZ:**

**WP2**: The activity of maintaining the technical framework of the portal and adapt it to changing content and load (WP2, Task 3) only requires 12 out of the 24 PM initially planned, as DKRZ managed to optimise their internal staff resources to complete this work.
**Therefore, DKRZ is releasing 66 000€ direct costs to the consortium for WP2.**

**Total available from DKRZ: 66 000€ direct costs representing 70 620€ in EU funding**

- **CSAG**:

**NA4 Task 2** on Meta-data, interoperability and standardization will only require 6 out of 9 PM planned, which represent a spared amount of 10 500€ direct cost. Indeed, so far 4 PM were spent for this activity, and only another 2 PM will be used on meta-data development, specifically for the CORDEX-ESD development in collaboration with University of Cantabria.
**NA4 Task 3** on requirements for the impact user communities will only require 4 out of 5 PM planned, which represents a spared amount of 3 500€. 2 PM were spent so far and another 2 PM will be used on comparing portals.
**Therefore CSAG is releasing 14 000€ direct cost to the consortium from WP5, i.e. 14 980 € EU funding.**

**JRA3 Task 1** on Core data services should require all resources planned.
**JRA3 Task 3** on Data access services for climate impacts will only require 6 out of 10 PM, which represents a spared amount of 14 000€ direct cost. 3 PM were used so far and CSAG would want to invest another 3 PM to this work only, due to a reduced internal capacity within the next year of the project.
**Therefore CSAG is releasing 14 000€ to the consortium from WP11, i.e; 16 800 € EU funding.**

**Total available from CSAG: 28 000€ direct cost representing 31 780€ in EU funding**

**TOTAL AVAILABLE (EU funding): 126 400€**

***Summary of money released to the consortium:***

| RELEASED | Pm | Pm cost | Travel | total EU |
|---|---|---|---|---|
| **DKRZ** | | | | |
| WP2 - NA1 | 12 | 66 000 | | **70 620** |
| **CNRS** | | | | |
| WP1 - USA | | | 10 000 | 16 000 |
| WP1 - GA meetings | | | 5 000 | 8 000 |
| Total | | | 15 000 | **24 000** |
| **CSAG** | | | | |
| NA4 - T2 and T3 | 4 | 14 000 | | 14 980 |
| JRA3 - T3 | 4 | 14 000 | | 16 800 |
| Total | 8 | 28 000 | | **31 780** |
| **TOTAL** | | | | **126 400** |

**Needs for extra money**

We have discussed and adopted at the 2nd General Assembly the following reallocations, justified by additional workload or travel needs, fully justified and which will bring an added value to the project.

- **CNRS-IPSL**

**WP11**: using an additional 6 pm, amounting to 30 000€ direct cost, on WP11/JRA3, CNRS-IPSL will further develop the software Synda (ex synchro-data) that is becoming the reference software for the ESGF replication. It is used worldwide by climate data centres but also by some power users interested in bulk download. Synda took a larger place that initially anticipated by the DoW. CNRS-IPSL also requests additional funding amounting to 4 000€ for missions and travels. In particular to attend the ESGF Face to Face US conference and various European coding sprint that proved to be very efficient advancing the software.

**Total to be reallocated to CNRS: 34 000€ direct cost representing 40 800€ in EU funding**

- **UC:**

**WP11:** University of Cantabria is asking for 27 000€ to cover 6 PMs cost of a new activity related to JRA3 task 1.2 (Data services), which aims to define new metadata for CORDEX-ESD data, and publish experiment data from the COST-VALUE initiative, already producing ESD datasets, which will part of the experiment protocol definition in CORDEX-ESD. This activity is also interacting with WP5 Task 2 on Meta-data, interoperability and standardisation. We also reallocate 4 000€ to UC to support a few more travels, to attend Project Work meetings and IS-ENES2 last General Assembly.

**Total reallocated to UC is: 31 000€ direct cost representing 37 200€ in EU funding**

- **CERFACS**

Funds for travel to IS-ENES2 meetings and workshops have run out. In order to ensure CERFACS attendance to last period meetings, 9 400€ will be allocated to this partner, distributed as follows:

**WP2**: CERFACS asks for 1 000 € direct cost to cover Jean-Claude André's travel costs until the end of project. Jean Claude André is leading the IS-ENES2 HPC task force and in this respect, he needs to establish and keep strong links with the HPC community in France and in Europe.

**WP9**: CERFACS plans to extend WP9 activity related to performance measurement. A fruitful synergy with GFDL (Geophysical Fluid Dynamics Laboratory, Princeton) scientists leads to define a standardized set of metrics suitable for all models involved in CMIP6 (Climate Models Inter-comparison Project) experiments. It is proposed to circulate this standard through the European laboratories, along with a dedicated support for actual measurement and collecting information to help improve this standard. For a total of 6 visits (2-3 days), CERFACS asks for 3 400€ direct cost.

**WP10**: CERFACS asks for 1 500 € direct cost to attend to one coding sprint in the UK, as part of WP10 activity on coupling benchmarks, and 1 000 € direct cost to attend final General Assembly.

**WP11**: CERFACS asks for 2 500 € direct cost for one ESGF face-to-face meeting in December 2016 in Washington (related to task 3 on Data access services for climate impacts)

**Total reallocated to CERFACS is: 9 400€ direct cost representing 7 916€ in EU funding**

**TOTAL NEEDED (EU funding): 85 916€**

***Summary of money to be reallocated to IS-ENES2 partners***

| NEEDS | Pm | Pm cost | Travel | total EU |
|---|---|---|---|---|
| **CNRS-IPSL** | | | | |
| WP11 - JRA3 | 6 | 30 000 | 4 000 | **40 800** |
| **CERFACS** | | | | |
| WP9 - JRA1 | | | 3400 | 2 038 |
| WP10 - JRA2 | | | 2 500 | 2 771 |
| WP11 - JRA3 | | | 2 500 | 2 038 |
| WP2 - NA1 | | | 1 000 | 1 070 |
| Total | | | 9400 | **7 916** |
| **UC** | | | | |
| WP11 - JRA3 | 6 | 27 000 | 4 000 | **37 200** |
| **Total** | | | | **85 916** |

We are currently gathering other requests for funding, to cover the surplus of **40 484€** that has not been reallocated yet. Indeed, some of the release was not yet fully settled at the 2nd General Assembly (uncertainties remained for CSAG). These propositions still need further discussion and approval by the overall consortium, which is why we do not report on them here. Once the consortium reaches an agreement on how to reallocate this leftover, we will inform the European Commission.

## Cooperation with other projects/programmes

*European Projects*

**SPECS:** IS-ENES2 collaborates with the FP7 SPECS project on seasonal to decadal climate predictions for climate services. Indeed, SPECS provides its model results on ESGF. SPECS benefits from IS-ENES2 experience to install data nodes on ESGF through STFC, from provider support and access to software tools.

**ECOMS:** ECOMS is the coordination of European projects on climate modelling and climate services. IS-ENES2 has participated to ECOMS and provided input to recommendations prepared for H2020.

**EUDAT:** ENES community is represented in EUDAT through IS-ENES2 partners (DKRZ, MPG and CERFACS). A strong link is established with issues such as metadata and data citation. IS-ENES2 will continue collaboration with EUDAT2 including STFC in the collaboration.

**SWICCA:** "Service for water indicators in climate change adaptation", Copernicus Climate Change Service Project run by SMHI to provide data for climate impact assessments. http://swicca.climate.copernicus.eu

**COST VALUE**: VALUE is n European COST Action on "Validating and Integrating Downscaling Methods for Climate Change Research ». Collaboration has been established with IS-ENES2 on metadata standards and the publication of data on ESGF.
http://www.value-cost.eu/

*International programmes*

**WCRP:** IS-ENES2 is strongly linked to WCRP activity in climate modelling. It supports the European contribution to the data infrastructure ESGF for international global and regional climate model experiments. A MoU is under preparation to recognise the role of IS-ENES2 in the implementation of CORDEX results on ESGF. Several partners of IS-ENES2 participate to the newly established Infrastructure Panel (WIP).

**ESGF:** Earth System Grid Federation is the international database for climate model results. Thanks to IS-ENES and IS-ENES2, European partners have acquired a strong role in ESGF software maintenance and development and are responsible for some activities. International governance is under discussion with DoE.

**ES-DOC:** Earth System Documentation is an international collaboration led by US on metadata standard for climate models. IS-ENES2 partners play a key role in the development of metadata software and standard.

**NCPP:** The National Climate Predictions and Projections Platform is a US program that aims to provide local climate information to inform decision on climate adaptation. Collaboration has been established with IS-ENES2 with developments done within the climate4impact portal. Common work is done on metadata for downscaled products and some common software will be used.

**RDA:** ENES is represented in the international Research Data Alliance by Michael Lautenschlager. This allows linking our activities with RDA.

# Annex: Acronyms

**CCMI**: is the international "Chemistry-Climate Model Initiative" endorsed by WCRP (SPARC) and IGBP (IGAC) programs (http://www.met.reading.ac.uk/ccmi/)

**CDO**: Climate Data Operators (http://www.mpimet.mpg.de/cdo) - collection of about 100 functions developed by the MPG for handling and analyzing data produced by a variety of climate and NWP models - e.g. for file operations, simple statistics, or the calculation of climate indices. The code is used by around 150 groups (220 users) world-wide, including some of the project partners, calling the CDO around 200000 times per day.

**CF**: Climate and Forecast Metadata Convention (http://cf-pcmdi.llnl.gov/) - International standard for model data files format.

**CIM**: Common Information Model - The FP7 METAFOR project has developed this standard.

**CIRCLE2**: FP7 Eranet « Climate Impact Research & Response Coordination for Europe" http://www.circle-era.eu/ promotes networking activities and common calls on adaptation to climate change. It focuses at the interface between research and policy.

**CLIMATE4IMPACT**: ENES Portal for Climate Impact Communities (http://climate4impact.eu) developed within IS-ENES and IS-ENES2 to ease access to model data for the climate impact research communities

**CMIP5:** Coupled Model Intercomparison Project Phase 5, under the auspices of WCRP to prepare IPCC AR5 **(**http://cmip-pcmdi.llnl.gov/cmip5/**)**

**COPERNICUS:** European initiative for the implementation of information services dealing with environment and security (previous Global Monitoring for Environment and Security) (http://www.copernicus.eu).

**CORDEX:** "Coordinated Regional downscaling Experiments" under WCRP auspices (http://wcrp.ipsl.jussieu.fr/SF_RCD_CORDEX.html).

**CORDEX-ESD:** stands for the regional data obtained from Experimental Statistical Downscaling http://www.cordex.org/index.php?option=com_content&view=article&id=222&Itemid=714

**COSP:** Cloud Observing System Package (http://cfmip.metoffice.com/COSP.html) has been developed to simulate cloud satellite observed parameters from climate model data in order to allow a more direct comparison with satellite data. It is available from MetO.

**EEA:** European Environment Agency (http://www.eea.europa.eu)

**ENES**: European Network for Earth System Modelling (http://www.enes.org) - A consortium of European institutions aiming at helping the development of use of ESMs for climate and Earth System studies.

**EPM**: IS-ENES European Project Manager

**ES-DOC:** Earth System Documentation (http://es-doc.org ) is an international collaboration led by US on metadata standard for climate models.

**ESGF:** Earth System Grid Federation (http://www.earthsystemgrid.org/) is an international collaboration with a current focus on serving the WCRP CMIP project and supporting climate and environmental science in general. The ESGF grew out of the larger GO-ESSP community.

**ESM**(s): Earth System Model(s). These models are developed to simulate the climate system in its full complexity, i.e. atmosphere, ocean and land which are the basic components included in climate

models together with biogeochemical cycles, i.e., carbon cycle, vegetation, aerosol and chemistry processes.

**ESMF**: Earth System Modelling Framework (http://www.esmf.ucar.edu/)- Devoted to define standards in the designing of climate model components for easier exchange and coupling, US-led

**EUDAT:** FP7 project "European Data Infrastructure" (http://www.eudat.eu/) launched on Oct 1rst 2011, aims at providing a pan-European solution to the challenge of data proliferation in Europe's scientific and research communities. MPG and Cerfacs represent ENES in this consortium

**Exascale:** for exascale computing, refers to computing power corresponding to $10^{18}$ operations per second. It is thousand times more powerful than present top computing facilities. It is expected to be available around 2018.

**GO-ESSP**: Global Organization for Earth System Science Portal (http://go-essp.gfdl.noaa.gov/) - Addresses the development and dissemination of standards for exchange of datasets in the field of Earth system science.

**HPC**: High Performance Computing

**I/O**: Input/Output is the generic process of exchanging data during a simulation, either as input to the model or as output of model simulations

**ICON:** is a new dynamical core project run by MPG and Deutscher Wetter Dienst based on icosaedral grids for atmosphere and ocean global models **(**http://icon.enes.org/**)**

**ICT:** Information & Communication Technology

**IPCC:** Intergovernmental Panel on Climate Change (http://www.ipcc.ch) - Provides regular scientific assessments reports (AR) on climate change issue under the auspices of UNEP and ICSU. The last one is the AR4 produced in 2007; the next one is AR5 to be issued in 2013

**IS-ENES (or IS-ENES1) : I**nfra**S**tructure for the **E**uropean **N**etwork for **E**arth **S**ystem Modelling, first phase**; FP7 project (**http://is.enes.org **)**

**LIM:** Louvain-la-Neuve sea ice model **(**http://www.astr.ucl.ac.be/index.php?page=LIM Description**)** – A Sea Ice Model

**METAFOR**: Common Metadata for Climate Modelling Digital repositories (http://ncas-cms.nerc.ac.uk/METAFOR/) - FP7 infrastructure project under ENES, which focuses on developing common standards for data and model information exchange that will be implemented in IS-ENES.

**NCAR**: National Center for Atmospheric Research in Boulder, USA (http://www.ncar.ucar.edu/)

**NEMO**: Nucleus for European Modelling of the Ocean (http://www.locean-ipsl.upmc.fr/NEMO/) - State-of-the-art modelling framework including 3 components: an ocean general circulation model (OPA), a sea-ice model (LIM) and a biogeochemistry model (TOP); NEMO is interfaced with all European atmospheric models via the OASIS coupler.

**netCDF**: network Common Data Form (http://www.unidata.ucar.edu/software/netcdf/) - A set of software libraries and machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data

**NCPP:** US National Climate Predictions and Projections Platform

**NOAA**: National Oceanographic and Atmospheric Organisation, USA (http://www.noaa.gov/)

**OASIS**: Ocean Atmosphere Sea Ice and Soil coupler (http://www.cerfacs.fr/globc/software/oasis/) – A software component allowing synchronized exchanges of coupling information between numerical codes representing different components of the climate system.

**Obs4MIP**: Observations for Model Intercomparisons Project is an activity to make observational products more accessible on ESGF for climate model intercomparisons (https://www.earthsystemcog.org/projects/obs4mips/).

**PCMDI:** Program for Climate Model diagnosis and Intercomparison, (http://www-pcmdi.llnl.gov/ ) at Lawrence Livermore National Laboratory (USA) has the responsibility for supporting modelling studies CMIP5.

**PRACE**: Partnership for Advanced Computing in Europe (http://www.prace-project.eu/) - An FP7 infrastructure project devoted to prepare the implementation of world-class high-performance computers in Europe.

**SPECS:** new Environment FP7 project "**S**easonal-to-decadal climate **P**rediction for the improvement of **E**uropean **C**limate **S**ervices » (2012-2016)

**v.E.R.C.**: virtual Earth System Modelling Resource Centre

**WCRP**: World Climate Research Programme (http://www.wmo.ch/pages/prog/wcrp)

**WGCM**: Working Group on Coupled Models (http://www.clivar.org/organization/ wgcm/wgcm.php) - Under WCRP defines the international strategy for climate model evaluation and simulations for IPCC reports

**XML**: Extensible Markup Language