IS-ENES – WP 2

D 2.5 Science Policy delivery of "The ENES Strategy and its implementation Plan"

Abstract:

This second policy position paper on "The ENES Strategy and its Implementation Plan" summarizes how the "Infrastructure Strategy for the European Earth System Modelling Community 2012-2022" that was released in April 2012 was presented to European research policy makers and which initial steps were taken to start the implementation of the strategy during the last year of the IS-ENES project, providing the basis for further implementation steps to be taken during the implementation of the follow-up project IS-ENES2. In May 2012, the ENES Infrastructure strategy (deliverable D2.4) was presented at the Governing Board of JPI Climate gathering representatives of 12 European member states partners - at the ministry, research council or research institution levels - as well as observers such as the European Commission and the European Environment Agency. This was an opportunity to deliver main recommendations on issues on high-performance computing facilities, on models and model data, on human resources and the willingness to strengthen the European networking of the community through ENES.

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REVISION TABLE

Version	Date	Modified Pages	Modified Sections	Comments
Version 1	2013-01-28	Many	Some	Reinhard Budich: Some typos, some comments. § “Recommendations for High-performance computing“: needs a reordering § „Recommendations for model software“: I find rather weak, we need to empasize that exascale needs a mind-shift: Serial code is prohibited!
Version 2	2013-03-06			Submitted by Sylvie Joussaume
Version 2	2013-03-08			Version 2 agreed by Rob Swart without any corrections
Version 2	2013-03-11			Version 2 agreed by Reinhard Budich without any corrections

1. Description of the methodology followed

The objective of this policy position paper is to summarize the main conclusions of the ENES Infrastructure Strategy for 2012-2020 elaborated during the IS-ENES project which are envisaged to inform the setting of national and international research agendas in the area of climate change modelling infrastructure in Europe. In particular, this deliverable presents the delivery of the ENES Infrastructure document to European science policy as well as first steps taken during IS-ENES to implement the Strategy. It describes the methodology adopted for this delivery, the content of the presentation given at the JPI Climate Governing Board 3rd Session on May 12th 2012 in Amsterdam and some elements of discussion and conclusion. A copy of the slides is attached (Annex 1). Main conclusions of the ENES infrastructure strategy have also also presented in a large audience paper to be published in "Research and Innovation" journal in March 2013 (N°6) that is widely distributed in Europe in policy and science policy arena (Annex 2).

At the start of the project, it was intended to derive a position paper version of the Infrastructure strategy document (D2.4) targeted to a policy maker audience and to organise a dedicated workshop. In the context of organizing the workshop on user needs in collaboration with the European Environment Agency and the ERA-Network of Climate Change Impacts, Vulnerability and Adaptation, CIRCLE2 in January 2011, and presenting and discussing its recommendations (see deliverable 2.2), it became clear that the main category of policy makers interested in and relevant for the infrastructure strategy involves research policy makers and research funders rather than those involved in climate or other policy areas. With the development of the Joint Programming Initiative on Climate (JPI Climate) not foreseen when the IS-ENES was proposed, it was decided that this audience, which involves 12 countries as partners as well as a representative of DG R&I, would be an excellent audience for the purposes of disseminating and discussing the strategy. The title of the deliverable has been changed accordingly. Beyond this presentation, the involvement of Sylvie Joussaume, as chair person of the JPI Working Group on "Moving towards decadal prediction" and Rob Swart as chair person of the JPI Working Group on "Climate Change Decision Support Methods and Tools" as well as some other experts involved in IS-ENES, contributes to ensure a development of JPI agenda and recommendations to Horizon2020 consistent with the ENES strategy. The ENES strategy has also had a major impact on the design of the follow-up IS-ENES2 project, which will start in 2013: It will implement some of the recommendations of the strategy, account for recent developments in climate policy and science during 2012.

JPI Climate gathers 12 member states in Europe and has as its central objective to better inform society on climate change. For this it relies on improving predictions of climate change at the decadal time scale, on developing research for climate services which aim at better informing society on climate change to help adaptation, on understanding the transformation of society and improving decision-maker tools.

ENES and its infrastructure, supported through the FP7 IS-ENES project, are fully relevant to the objectives of JPI Climate. ENES gathers the climate modelling community working to deliver information on how climate is affected by human activities and their impact on the atmospheric composition. IS-ENES infrastructure delivers data from model results performed within international coordinated numerical experiments, such as the Coupled Model Intercomparison Project Phase 5 (CMIP5) and the Coordinated Regional Downscaling Climate Experiments (CORDEX). This information is at the basis of the information delivered to society through IPCC Assessment Report as well as through the emerging climate services. IS-ENES helps to interface the climate modelling with the large European computing facilities of PRACE.

The ENES Infrastructure strategy was presented to the 3rd Governing Board session of JPI Climate that took place in Amsterdam on May 12th, 2012. The Governing Board (GB) indeed gathers representatives of the member states partners of JPI Climate - ministries in charge of research or environment, of funding agencies, such as national research councils, and of research organisations- as well as observers such as the EC (environment research), the European Environment Agency, the Eranet Circle2, the consortium ECRA. Members of the Governing Board are therefore all in charge of science policy. Several representatives in the GB also participate to UNFCCC Conferences of the

Parties and are therefore also very familiar to policy makers requirements. A side-event was therefore organised at the JPI GB meeting. The final foresight paper (D2.4) was distributed, as well as a leaflet on IS-ENES, and a talk was given to present the main issues and conclusions of the strategy. The main elements of the talk are summarised in part 2.

IS-ENES coordinator Sylvie Joussaume also presented the Strategy to and discussed it with key climate system experts and research managers in the United States during a period as visiting scientist at NCAR in Boulder. This allowed not only to explain the European collaboration on climate research collaboration to US counterparts, but also to further develop the ideas about the implementation of the Strategy in an international context.

2. Presenting the Strategy and starting its Implementation

Introduction to ENES and its infrastructure

ENES was initiated following a first foresight done within the Concerted Action “Euroclivar” in 1998. ENES is a European network set in 2001 that gathers more than 40 groups. ENES aims at discussing strategy and accelerating progress in the modelling of the Earth’s climate system. ENES gathers several EU projects which are of interest to climate modelling and to JPI Climate. ENES addresses issues such as the development and evaluation of climate models (COMBINE, EMBRACE, EUCLIPSE), the realisation of CMIP5 experiments (COMBINE), the development of decadal prediction (COMBINE and SPECS), the possibility of future abrupt changes (EMBRACE) to cite the most recent projects. ENES furthermore plays an important role in the discussions on the development of the European nodes of a global network of Climate Services, and have close connections with European projects supporting this development, such as ECLISE and CLIMRUN.

Climate modelling is highly dependent on infrastructures. These include: software (models and modelling tools), model databases and high-performance computers. Since 2007, ENES infrastructure has been supported by the EC through the IS-ENES project in its first (2007-2013) and soon its second phase (2013-2017). The infrastructure focuses on software to increase sharing of models and tools, on model data with the European contribution to the international database set up for CMIP5, called the Earth System Grid Federation. As regards to high-performance computing (HPC), the community relies on national and now also European facilities with the new large European infrastructure PRACE. IS-ENES helps the community with regards to HPC through the development of collaboration with PRACE as well as through technology tracking and sharing of common developments to prepare for future computing architectures; IS-ENES gathers the seven European climate models that have contributed to CMIP5 and which are all supported by member states which are partners of the JPI Climate (Germany, UK, France, Italy, Norway, Netherlands, Sweden, Spain at least).

The ENES infrastructure strategy

Climate modelling research is driven by both science and societal questions with issues ranging from the understanding of climate variability and climate change to the development of knowledge and climate information to be used by climate services to deliver information to society. During the two workshops that have led to the strategy document, five main issues have been emphasized covering:

- What is needed to provide meaningful predictions of regional changes in climate at different time scales and including extreme events, which are useful for informing the development of particular adaptation measures?
- How predictable is climate, in particular at the seasonal and decadal time scales relevant for different types of decision makers?
- What is the sensitivity of climate, i.e. the amplitude of feedbacks, such as cloud feedbacks, and does the system exhibit nonlinear behaviours that may lead to abrupt changes and disruption of society, a question in particular relevant for high-end scenarios?
- Can we attribute observed signals in particular climate variables and understand processes?
- Can we model and understand glacial-interglacial cycles as recorded from past changes and thus enhance our confidence in our understanding of the mechanisms occurring within the Earth’s climate system?

The main and most dimensioning challenge for climate modelling identified by the ENES community is to develop on the long-term global climate models that can reach the kilometre scale spatial resolution. This scale represents a large step in scales as it allows representing explicitly deep-convective clouds, which play an important role in the exchange of energy within the climate system. Moreover, this scale should allow a much better representation of processes at regional scale such as topography, land-ocean contrasts, urban areas … and should, hopefully, improve the quality of projections at the regional scale, integrating the currently existing different sets of global and regional climate models. The global km-scale target is particularly challenging as it requires the community to develop new parameterisations of processes and efficient use of future exascale computer

technologies based on a very high number of parallel processors. Some first steps are just taken with simulations at the 30 km scale - compared to the more common resolution used today of 150-200 km - using PRACE facilities.
Another important challenge is related to the improved understanding, quantification, and whenever possible the reduction, of uncertainties in climate projections. Those require accounting for uncertainties arising from: internal variability of the system, which are intrinsic to the climate system and require a higher number of simulations than usually affordable, a diversity of climate models as is emphasized within international coordinated experiments, and different socio-economic scenarios. Uncertainty quantification calls for a large number of experiments, and is also dependent on computing power.

Recommendations for High-performance computing

Both challenges call for more investment into powerful computer facilities and the climate simulation software using them efficiently than is currently available for climate science in Europe and even world-wide. In the US, large dedicated facilities have been implemented. In Europe, PRACE facilities are providing access to world-class facilities. But these facilities are general-purpose facilities, which are in almost all cases not adapted to the use by climate models (architecture, storage, operation of the machines). In Europe, it would thus be important to access world-class computing facilities adapted to climate computing needs. Europe may even need a specific, dedicated infrastructure if Europe wants to develop very high-resolution climate predictions/projections that would not only further enhance the understanding of the climate system and the associated uncertainties, but also support some components of national and international adaptation policy, as well as inform a debate about the desirable level of mitigation measures[1]. In order to achieve these challenges, ENES, as a first step, develops collaboration with PRACE facilities.

Recommendations for model software

Access to HPC facilities is not enough. There is also a need to improve model parameterisations, as also recognised by JPI Climate. In order to represent model uncertainty, Europe should keep some diversity in its climate models but, most probably, a better organised and structured diversity and a better harmonisation of model developments, might reduce the high burden of technical developments. The climate modelling community is also facing the need to revisit their codes in order to use with best efficiency the massively parallel computer architectures. This will require new choices of algorithms, numerical schemes, data structures. Strengthening European collaboration will help share the large range of developments required to prepare the future generation of Earth system models able to be run on future exascale computers able to compute 10^{18} operations per second and/or handle 10^{18} bytes of data.

Recommendations for data infrastructure

The international community has started to integrate databases related with international experiments such as CMIP5. IS-ENES is supporting the European contribution to this international effort, called the Earth System Grid Federation (EGSF), and even pushing to implement this approach also for CORDEX. IS-ENES strengthens the role of the European partners in ESGF. ENES has also been very active in developing international metadata standards, through the METAFOR project now extended to the ES-DOC collaboration between Europe and US, to be further supported by IS-ENES2. Further implementing this international approach is crucial to allow a better international exploitation of these experiments and improve our understanding of climate change. This effort also requires to be complemented by the interoperability with observational databases – which is not yet achieved- in order to enhance model evaluation and understanding of climate change.

Recommendations on interactions with users and stakeholders

There is also a need to ease access to model data to a wide range of users from the climate impact communities in order to better infer impacts of climate change on different sectors. IS-ENES has taken steps in that direction, and follows recommendations from a workshop organised jointly with the

[1] It should be stressed that many meaningful adaptation measures can be developed without high-resolution climate projections, and consequently such adaptation measures should not be postponed until such projections will become available.

Eranet Circle2 and the European Environment Agency, emphasizing the need for integrating global and regional model results, the need to include guidance on how to best use model results and on their limitations, the need for tools to help the use of all these data (see position paper/deliverable2.2). IS-ENES has started to implement a portal interface for the climate impact communities and will further expand this approach. In doing this, periodically the IS-ENES team interacts with the developers and managers of related portals, including CLIMATE-ADAPT which is managed by the EEA. Starting to implement the strategy, various team members are also involved in work of the Global Climate Services Platform, and others are involved in proposals that have been submitted to the Commission in the context of the SPACE programme and the Global Monitoring of Environment and Security initiative (GMES), focusing on improving access to climate data. Part of these connections with the broader research and policy communities is an increasing attention to the demands of the private sector, including energy and insurance companies, which work is partly taking place in consultation with climate adaptation services related projects of the Climate KIC initiative. Various contacts with the impacts research community, including the authors of the recent visioning paper: “Climate Impacts Research; a Vision for the Next Decade” have been established and will be further developed in the context of IS-ENES2.

Recommendations on human resources

Human resources are crucial to achieve the objectives to improve our capacity to deliver reliable information to society at the decadal and regional scale to prepare for adaptation. Enhancing networking is one of the approaches recommended by ENES to share developments and reduce the technical burden. Training will also be important more especially to be able to use new ICT technologies and help further common developments of the complex Earth’s climate system models. However, the use of future computing architectures will also require new expertise and more human resources.

Strengthening ENES

The ENES community faces several challenges: a scientific challenge to improve climate understanding, a societal challenge to improve reliability of climate information to prepare society to adaptation, and a technical challenge to face new computing architectures and the development of international data exchange and standards. These different challenges call for a stronger ENES organisation able to enhance collaboration among the different climate modelling centres, to reduce the technical burden and to enhance the overall efficiency of the European climate modelling community.

3. Discussion following the presentations and conclusion

The discussion after the presentation of the ISENES strategy for the JPI Climate Governing Board was mainly been focused on the recommendation to access world-class computing facilities dedicated for climate. Issues were raised on how to best justify such facilities with a recommendation made by some countries to avoid showing model results at the global scale that do not motivate policy makers which require information at the local scale. However, Sylvie Joussaume has explained how much and which kind of information at the regional scale is obtained through simulations at the global scale followed by various downscaling techniques, and that, for example the IS-ENES portal is designed for the climate impact community to display use cases on different scales. The issue was also raised how much energy computing facilities consume when used for high resolution modelling. It is a challenge for the climate science community to limit the large energy consumption required for their work. Further informal discussion took place showing a clear interest by JPI Climate GB on climate modelling science and infrastructure needs.

In conclusion, building on the ENES Infrastructure Strategy we can formulate the following recommendations for climate research policy:

- ***High-performance computing***. Collaborating with PRACE, specific, dedicated computer

infrastructure has to be developed to enable Europe to develop the high resolution climate predictions/projections for enhancing the understanding of the climate system and the associated uncertainties, and support inform adaptation and mitigation policies. Attention to reducing energy consumption of this infrastructure forms a challenge for making climate research itself more sustainable.

- ***Model software***. In order to represent model uncertainty, Europe should keep some diversity in its climate models but, most probably, a better organised and structured diversity and a better harmonisation of model developments, especially when facing the need to rewrite codes for massively parallel computing architectures

- ***Data infrastructure***. A long-term research infrastructure to access model data is emerging at the international level. Interoperability between model results, from different models and model components, with observational data systems, and with relevant impact models will require attention to allow efficient integrated climate system analyses.

- ***Interactions with users and stakeholders***: Over the next decade, the still fragmented and immature interactions with the disparate community of users and other stakeholders should be integrated, consolidated and further enhanced to guarantee an output that is both timely and effective.

- ***Workforce***. A concerted effort is needed to maintain and strengthen the technical and scientific expertise required to develop the required modelling improvements and analyse and communicate the results, through attracting and train new talented scientists, not only in the academic community, but also in the increasing group of practitioners, including private sector experts.

Appendix 1 :
Copy of the slides presented at the JPI Climate GB 12th May 2012

Slides are also available electronically at XXXXXXXX

Appendix 2 :
Paper to be published in Research and Innovation 6 (March 2013)