

Chapter 2

The Infrastructure Project of the European Network for Earth System Modelling: IS-ENES

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2.1 General Overview

The European Network for Earth System Modelling, ENES, gathers the European community developing and applying climate models of the Earth system. This community aims to better understand present and past observed climates and predict future changes under given boundary conditions of anthropogenic and natural forcing. It is strongly involved in the assessments of the Intergovernmental Panel on Climate Change (IPCC) and provides the predictions on which European Union (EU) mitigation and adaptation policies are based. The EU funded seventh Framework Programme (FP7) project IS-ENES,¹ which is finishing its first phase (2009–2013) and preparing for its second phase (2013–2016), aims to promote the development of a common distributed modelling research infrastructure in Europe in order to facilitate the development and exploitation of climate models and better fulfil the societal needs with regards to climate change issues.

The infrastructure dimension of Earth System modelling encompasses models themselves and their associated software, provision and access to model data, and provision and use of high-performance computing (HPC). IS-ENES focuses on all three issues, but does not include the provision of HPC hardware. IS-ENES is a distributed e-infrastructure with a central resource, the “ENES Portal”,² which provides access to models, tools and model data archives. The main objectives of the IS-ENES project are:

¹ <http://is.enes.org>

² <http://www.enes.org>

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- The integration of the European climate and Earth system modelling community;
- The development of Earth System Models for the understanding of climate change;
- High-end simulations enabling better understanding and prediction of future climate change;
- The application of Earth system model simulations to better predict and understand future climate change impacts.

2.2 Rationale and History

The ENES network was established in 2001 following a first foresight exercise performed by the community in 1998 within the EU Euroclivar concerted action (Komen et al. 1998) which recommended “*a better integration of the European modelling effort with respect to human potential, hardware and software*” and “*to develop collaboration, to establish a European climate computing facility, and to enhance the exchange of software and model results*”. These recommendations led to the establishment of ENES, as the European Climate Modelling Group advocated by Euroclivar. ENES set up the FP5 infrastructure project “Program for Integrated Earth System Modelling” (PRISM, see Chap. 4). PRISM carried out a successful first step towards the Euroclivar recommendations, establishing a network of expertise around ESM software environments and promoting a standard technical coupling interface now used world-wide, the OASIS coupler. This effort has helped to build the FP7 IS-ENES project (2009–2013) and the FP7 e-Infrastructure project, METAFOR, “Common Metadata for Climate Modelling Digital repositories”³ (2008–2011, see Chap. 3). Networking within ENES also led to collaborative projects funded within the EU Environment Program, dealing with future climate scenarios, Earth system model developments and evaluation of cloud processes and feedbacks, such as the FP6 ENSEMBLES⁴ and FP7 COMBINE⁵ and EMBRACE⁶ projects.

2.3 Partnerships and Organization

ENES gathers more than 40 institutions and organizations through a Memorandum of Understanding. These include climate modelling centres, computing centres and manufacturers, data centres and centres with expertise in computational science and technology. ENES is governed through a Scientific Advisory Board. An ENES HPC task force has been set up to elaborate a common strategy on HPC and to help provide a common interface to the European high-performance

³ <http://metaforclimate.eu>

⁴ <http://www.ensembles-eu.org>

⁵ <http://www.combine-project.eu>

⁶ <http://www.smhi.se/embrace>

computing infrastructure PRACE (Partnership for Advanced Computing in Europe).⁷ It is anticipated that a similar group on data aspects will be established in the future, interfacing ENES with the international Earth System Grid (ESG) partnership. Within IS-ENES, a subset of 18 ENES partners from 10 European countries is involved in the project. IS-ENES gathers the European global Earth System Models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) namely, the UK Met Office model, the German COSMOS/MPI-ESM model developed at the Max Planck Institute of Hamburg, the French Institut Pierre Simon Laplace (IPSL) and Meteo-France models, the Italian Centro Euro-Mediterraneo per i Cambiamenti Climatici climate model, the EC-Earth model developed from the ECMWF model by a consortium of 8 countries, and, now joining in IS-ENES2, the Norwegian ESM. To address issues related to HPC, several computing centres are involved including the Deutsches Klimarechenzentrum (DKRZ), the Barcelona Supercomputing Centre and the Swedish National Supercomputing Centre, as well as centres dedicated to computational science such as CERFACS and University of Manchester. Work is organized through networking, service and joint research activities around models, HPC and data.

2.4 Overview of Results

The integration of the European Earth System modelling community is an important ambition of IS-ENES. The strategy of the community for the next ten years regarding the European infrastructure needs for ESM was issued in 2012 (ENES 2012). Integration has also been developed through more specific objectives such as the development of the ENES Portal which provide access to IS-ENES services, information relevant for the community, and conducted the first European school on ESMs for young scientists. In order to foster the development of ESMs, IS-ENES has started a support service on modelling including access to the European ocean modelling platform NEMO,⁸ the OASIS Coupler and the Climate Data Operators post-processing tools (CDOs). The ENES portal developed within IS-ENES also provides access to climate model documentation and on tools and datasets used for model evaluation. Access to world-class high-performance computing is important for the climate modelling community in order to better understand climate and its dynamics and provide information to society. In order to fulfil this objective, IS-ENES has developed collaborations with PRACE to help the preparation of climate models on PRACE machines. Developments have also been made on improving input/output data exchange and coupling software, which are two bottlenecks for massively parallel simulations. A significant effort has been devoted to the deployment of the European contribution to CMIP5. As a result, European nodes have been among the first to publish data, the first to meet agreed data access standards

⁷ <http://prace-project.eu>

⁸ <http://www.nemo-ocean.eu>

and the first to complete the second level of the 3 level quality control process. Through IS-ENES, the two European data portals, the British Atmospheric Data Centre and the DKRZ data centre, have developed quality control of ESG federation data archives. A prototype of a portal for the impacts community has been developed that provides access to documented use cases (see Chap. 3) on methodology aspects.

2.5 Users

The most important users are clearly from the global climate modelling community. However, the developments in the IS-ENES project also serve the regional climate modelling community through sharing of common tools with the global climate modellers and analysts. Thus, for example, these developments have resulted in the coupler OASIS being increasingly used to develop coupled regional Earth System Models and the CDOs. Another important target group is the impacts community that is extensively using the results from climate simulations to force different sectorial impact models. The prototype portal for the impacts community aims at describing how best to use results from climate models and provide visualisation and targeted access to model results. More generally, the ENES infrastructure is expected to improve use and usability of climate models and the dissemination of their results for the benefit of society.

2.6 Future Plans

The 2012 ENES strategy has guided the elaboration of the second phase of IS-ENES. IS-ENES2 is built upon the outputs of both the FP7 IS-ENES and METAFOR projects. It will further integrate the European climate modelling community, stimulate common developments of software for models and their environments, foster the execution and exploitation of high-end simulations, and support the dissemination of model results to the climate research and impacts communities. More specifically, phase 2 will extend ENES services on data from global to regional climate models by supporting results from the World Climate Research Program “Coordinated Regional climate Downscaling Experiments” (CORDEX). The project will also support further metadata developments and ease access to climate projections for the climate impacts community with a common portal for global and regional climate models, including guidance and downscaling tools. Furthermore, common high-resolution modelling experiments for the large European computing facilities will be prepared by the project, underpinning the community’s efforts to prepare for the challenge of future exascale computing architectures. The climate modelling community is facing a strong challenge to provide more reliable information to society to prepare for adaptation to climate change. It is expected that this European infrastructure will contribute to it.

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