

REQUEST FOR A SPECIAL PROJECT 2014–2016

MEMBER STATE: Sweden

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Project Title:

Regional European re-analysis with HARMONIE for UERRA (RERA)

If this is a continuation of an existing project, please state the computer project account assigned previously.	SP _____	
Starting year: <small>(Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)</small>	2014	
Would you accept support for 1 year only, if necessary?	YES <input type="checkbox"/>	NO <input checked="" type="checkbox"/>

Computer resources required for 2014-2016: <small>(The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2016.)</small>	2014	2015	2016
High Performance Computing Facility (units)	30,000,000	30,000,000	30,000,000
Data storage capacity (total archive volume) (gigabytes)	40,000	60,000	80,000

An electronic copy of this form **must be sent** via e-mail to: *special_projects@ecmwf.int*

Electronic copy of the form sent on (please specify date):
.....**2013-06-26**.....

Continue overleaf

¹ The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide an annual progress report of the project's activities, etc.

Principal Investigator: Heiner Körnich

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Extended abstract

It is expected that Special Projects requesting large amounts of computing resources (500,000 SBU or more) should provide a more detailed abstract/project description (3-5 pages) including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The Scientific Advisory Committee and the Technical Advisory Committee review the scientific and technical aspects of each Special Project application. The review process takes into account the resources available, the quality of the scientific and technical proposals, the use of ECMWF software and data infrastructure, and their relevance to ECMWF's objectives. - Descriptions of all accepted projects will be published on the ECMWF website.

Regional European re-analysis with HARMONIE for UERRA

Heiner Körnich, Per Undén (SMHI)

This project applies for High-Performance Computing resources in order to create a regional European re-analysis data set with the HARMONIE (Hirlam Aladin Regional / Mesoscale Operational NWP in Europe) modelling system. We aim for a high resolution of at least 11 km horizontally and 65 levels vertically. The reanalysis will start in 1961 and go to present-day. A 3-dimensional variational (3D-VAR) data assimilation will be employed. Over a shorter timespan, a multi-physics mini-ensemble will be run with different physical parameterisations.

The results from the proposed project will contribute directly to the European FP7 (7th Framework Programme) project UERRA - Uncertainties in Ensembles of Regional Re-Analyses with 12 institutes from 7 EU countries, Switzerland and an international organisation (ECMWF), coordinated by Per Undén (SMHI).

In the European Union FP7 project UERRA, an ensemble system of regional reanalyses will be developed and run for the climatological time scale. The information content of the datasets and their uncertainties will be assessed in several ways and statistics analysed.

UERRA will provide long-term datasets of Essential Climate Variables (ECVs) on the European regional scale in order to support adaptation action and policy development. The datasets will contribute to Climate services for Copernicus, climate monitoring and research.

Regional reanalyses will be made in Ensemble mode and there will also be individual reanalyses with different models and methods. Observational data rescue (digitizing data in archives not currently available for use) will continue from the European project EURO4M (European Reanalysis And Observations For Monitoring) and enhanced gridded datasets will be developed and used for validation. The ensembles together with gridded datasets will form the basis for estimation of uncertainties of the constituent members. Large datasets will be built up and open and user-friendly access methods will be established together with the work in other topics of the SPACE call.

The project UERRA builds on the experiences and developments in EURO4M but now the reanalyses will cover climate analysis time scales (30 to 50 years) and pioneer ensemble techniques for regional scale and high-resolution reanalysis. It will build on and extend the global reanalyses (ERA-CLIM-1, ERA-20C, ERA-CLIM and ERA-Interim).

Further downscaled high-resolution reanalyses will also be performed where more near surface ECV observations can be utilized. Indicator information (including uncertainties) will be applied to the reanalyses and there will be extensive validation against remote sensing and hydrological data.

They will add to the validation effort, respond to user requirements, and demonstrate how the reanalysis information is best utilized for understanding past climates and climate change.

Scientific Plan

1. HARMONIE reanalysis

SMHI with involvement from Météo-France will set up and run a 3D-VAR regional reanalysis with the HARMONIE modelling system. The system is developed and used within the HIRLAM and ALADIN consortia. It will be implemented and optimised for the entire European area with surrounding sea areas (Fig. 1) at as high resolution as is possible (11 km and at least 65 levels). It will be run from 1961, and serve as one member of a multi-model reanalysis. The data will be archived in MARS at SMHI and at ECMWF.

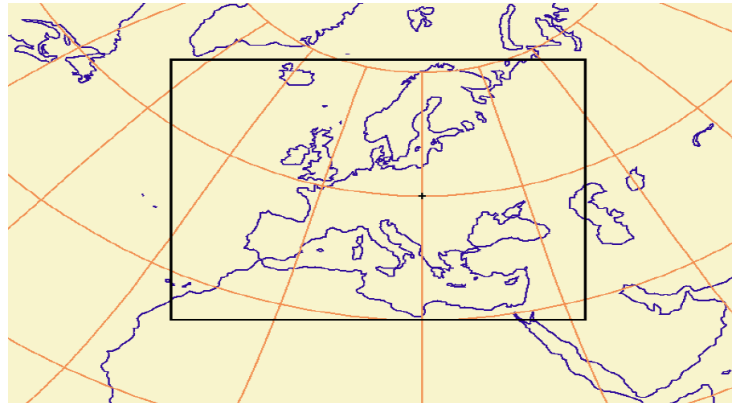


Figure 1: Domain covered in UERRA reanalyses.

As the HARMONIE system is based on ECMWF IFS and as it is regularly run on ECMWF supercomputers, we expect no major technical problems with the code.

The data assimilation will be driven by the global ECMWF ERA-SAT reanalysis (with earlier ERA reanalysis as backup) and also use a large scale Jk constraint (Dahlgren, 2011) to add large Atlantic scale information from ECMWF satellite assimilation into the 3D-VAR minimisation.

The coupling between the global and regional reanalyses can further be enhanced through a constraint in the variational cost function, J_k . It is designed to include a measure of the distance to the external global analysis for the large scales only. This has been developed in HIRLAM by Dahlgren (2012) and before that in somewhat different way by Guidard et al. (2008) in ALADIN. The methods are being further developed in the current HARMONIE 3D-VAR system used in this project. This can be seen as a way of imposing signals from the satellite data used in the global ECMWF system into HARMONIE 3D-VAR.

2. Multi-physics mini-ensemble

HARMONIE is available with different modelling of the sub-grid (scales not resolved) of physical processes like turbulence, convection, condensation, clouds, precipitation and radiation. The existing parameterisation schemes, such as those at Météo-France (ALADIN) and the more recent ALARO designed for multi-scales, will be employed. Both will be run and evaluated for at least a 5 year period on the 11 km European grid.

3. Downscaling analyses and downstream products

The upper air HARMONIE RA will be further enhanced through down-scaling and higher (5.5 km) resolution 2D analysis of ECVs. In UERRA this will build on the work in EURO4M and the common tool MF-SMHI, MESCAN. The added value compared to the 11 km UERRA reanalysis will be gained from both high-resolution observation datasets and from high-resolution physiographic fields as well as adapted structure functions for the spatial scales. Météo-France will set up and carry out a pan-European reanalysis with MESCAN, which is developed during the EURO4M project with SMHI. It will provide a near surface analysis for temperature, relative humidity, precipitation and wind. Météo-France will downscale the 3D-VAR HARMONIE analysis as an input field or background for the 2D-analysis system MESCAN at 5.5 km.

A coherent 5 km dataset of near-surface ECVs extending back to 1961 will be a unique asset for all the European National Meteorological and Hydrological Services and all other users of climatological data. This reanalysis will be a single deterministic one for most of the period, but for period of 5 years there will be two downscaling reanalysis driven by the two different physics

parameterisations in HARMONIE mentioned above. These will introduce differences in the downscaling from the model backgrounds used and the basic observations are the same in the two runs. Additional perturbations may be introduced by also perturbing the observations. This spread between the two datasets will give a unique and novel measure of uncertainties at very high resolution.

4. The role of the Special Project and connections with UERRA.

The ECMWF computer resources will be needed for running the HARMONIE 11 km reanalyses including the period with different physics parameterisations. The computational needs are very large and SMHI seeks various ways of enabling the reanalysis to be produced, both as Special Project and National ECMWF allocation as well as on National resources in Sweden. Probably the work will be split up in different streams. None of these three computing allocations will suffice on its own, but all three will be needed to carry out the extensive work.

Separately from this Special Project (RERA) the further downscaling at 5.5 km will be made by Météo-France. This work depends however entirely on the HARMONIE reanalysis. Both data sets together with data services and visualisation and other products coming out of UERRA will mean additional benefits outside RERA.

Estimation of requested computer resources

In SP5ERUR4 one year of HIRLAM reanalysis at 22 km takes 0.4 M units. HARMONIE is more demanding and takes 0.6 M units. Doubling the horizontal resolution means 5 M units for one year of reanalysis. 50 years will thus need as much as 250 M units. In this Special Project 90 M units are applied for while the rest will either be run from Swedish ECMWF resources or National computers. Furthermore the reanalysis will continue also one more year, after the end of this Special Project.

HIRLAM storage is about 2 TB per year and 11 km will need 8 TB. 50 years require 400 TB, but again not all of the reanalyses will be run under the Special Project.

Dissemination

Data sets from the HARMONIE reanalysis will be publically available and can be downloaded from a dedicated website. The publication of the data will be coordinated with another European FP7-project CLIP-C (Climate Information Platform for Copernicus). In CLIP-C, a web-interface will be implemented aiming at the publication of the EURO4M data set. A natural continuation will allow for including UERRA results.

UERRA results will be published in peer reviewed international journals or scientific reports. Presentations will be made at international conferences during the course of the project by many of the scientists working in the project. Close contacts will be maintained with the climate change community of the EU, EEA, WCRP and IPCC, both for regular updating of the progress in the project and as a way of getting user and/or societal feedback into the project.

References

Dahlgren, Per and Gustafsson, N, 2012: Assimilating Host Model Information into a Limited Area Model, *Tellus A* 2012, 64, 15836, DOI: 10.3402/tellusa.v64i0.15836.

Guidard, V. and Fischer, C., 2008: Introducing the coupling information in a limited area variational assimilation. *Q. J. R. Meteorol. Soc.*, 134, 723-735.