

# REQUEST FOR A SPECIAL PROJECT 2017–2019

**MEMBER STATE:** Sweden

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**Project Title:** Regional European re-analysis with ALADIN for UERRA (RERA)

If this is a continuation of an existing project, please state the computer project account assigned previously.	SPSERERA_____	
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>	2017	
Would you accept support for 1 year only, if necessary?	YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

<b>Computer resources required for 2017-2019:</b> <small>(To make changes to an existing project please submit an amended version of the original form.)</small>	<b>2017</b>	<b>2018</b>	<b>2019</b>
High Performance Computing Facility (SBU)	66,000,000	24,000,000	
Accumulated data storage (total archive volume) <sup>2</sup> (GB)	286,000	144,000	

**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):

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*Continue overleaf*

<sup>1</sup> 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.

<sup>2</sup> If e.g. you archive x GB in year one and y GB in year two and don't delete anything you need to request x + y GB for the second project year.

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## Extended abstract

*It is expected that Special Projects requesting large amounts of computing resources (1,000,000 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 ALADIN for UERRA

Heiner Körnich, Per Undén (SMHI)

This project applies for High-Performance Computing resources in order to continue the production of the regional European re-analysis data set with the ALADIN model within the HARMONIE (HIRLAM ALADIN Regional / Mesoscale Operational NWP in Europe) modelling system. We run at a resolution of 12 km horizontally and 65 levels vertically. The reanalysis starts in 1961 and will go to present-day. A 3-dimensional variational (3D-VAR) data assimilation is employed. During 2016, we expect to have finished about half of the planned time series. The second part will be produced during 2017, with an extension to recent dates during 2018. Furthermore, over a shorter timespan, a sensitivity study will be performed to examine the impact of dynamic vegetation on the regional reanalysis.

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. Production of the ALADIN reanalysis

SMHI with involvement from Météo-France has set up and run a 3D-VAR regional reanalysis with the model ALADIN within the HARMONIE modelling system. It was implemented and optimised for the entire European area with surrounding sea areas (Fig. 1) at the horizontal resolution of 12 km and with 65 vertical levels. The reanalysis was started with the year 1961 and will be produced to approximately current date, ie. in total about 55 years. The data will be archived in MARS at SMHI and at ECMWF.



*Figure 1: Domain covered in UERRA reanalyses.*

The data assimilation is driven by the global ECMWF ERA40 and ERA-Interim, since the ERA5 was not available when the production of UERRA started. We use also a large scale Jk constraint (Dahlgren, 2011) to utilize the large-scale information from ECMWF and, thereby include information from satellite assimilation into the 3D-VAR minimisation.

The production of the long ALADIN reanalysis was restarted, after the discovery and correction of a bug, in spring 2016. It is run in parallel with one decade per stream. We expect that we will finish about half of the entire reanalysis time series during 2016, i.e. 27.5 years. During 2017, we will produce the second half with another 27.5 years.

### 2. Impact of dynamical vegetation on the reanalysis

The interaction between the upper air part of the NWP model and the vegetation can have a strong impact especially on the near-surface state in the reanalysis, as vegetation affects albedo and evapotranspiration. In the employed surface model SURFEX, dynamic vegetation can be included to account for the feedback between weather and vegetation. We will conduct a sensitivity study on the impact of the dynamical vegetation on the regional reanalysis. To this end, we will run the ALADIN reanalysis with dynamic vegetation over the five-year period of the UERRA mini-ensemble reanalysis, i.e. the years 2005 to 2010. This data set will be compared against the UERRA reanalysis with prescribed vegetation.

### 3. Continued production and data analysis

Although the FP7-project UERRA ends in 2017, we plan to analyze the data, create an UERRA atlas, and continue production during the following year. We foresee that the years 2016 to 2018 will not be finished in 2017 and will be produced during 2018. Data analysis and the creation of a

UERRA-ALADIN reanalysis atlas will require some computational resources, but especially storage on ECFS.

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

The ECMWF computer resources will be needed to continue the production of the ALADIN 12 km reanalyses including the period with dynamic vegetation. 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. 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 ALADIN 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 SPSENERA one year of ALADIN reanalysis at 12 km takes 2.8 million SBUs. During 2017, the planned 27 years of reanalysis data will require 75.6 million SBUs. In this Special Project 66 million SBUs are applied for while the rest will be run from Swedish ECMWF resources. For 2018, we will run 5 years of reanalysis with dynamic vegetation and 3 recent years for the standard ALADIN reanalysis, requiring 22 million SBUs, and some data analysis estimated to 2 million SBUs.

For disk storage, ALADIN reanalysis produces about 18 terabytes per year. This means that 486 terabyte are needed for 27 years of reanalysis. In this way, all necessary model output required for further downscaling is stored, which allows a stronger data utilization of downstream projects. Thus, we apply for the limit of 268 terabytes during 2017. During 2018, only a total of 8 years of reanalysis will be produced, requiring 144 terabytes.

#### **Dissemination**

Data sets from the ALADIN reanalysis will be publically available from MARS at ECMWF 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.